Concrete

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The Trial of Eastern Cement Manufacturers

By Harvey Whipple
Editor "Concrete"

A CONSIDERABLE percentage of users of portland cement are probably of the opinion, or have at some time had the opinion, or at least a suspicion, that by some more or less systematic manipulation of the market they are "gouged," as the saying goes, in buying cement. This buying for a year in the United States amounts to about two hundred and fifty million dollars.

As a more or less direct result of such beliefs and suspicions, the Government investigated the cement industry in the East; a grand jury returned indictments; nineteen corporations and forty-four individuals are now on trial on criminal charges in United States Court in New York City.

Law violation, even when law violation is established, in such cases does not readily shape itself, for the mind of the general public in any such clear-cut set of circumstances as are likely to surround a poor man's theft of a loaf of bread from a bake shop.

It is unfortunate from the standpoint of both cement producers and cement consumers that the difference between a criminal act and a legitimate business transaction is not always a clear-cut and plainly understandable matter. The fabric of the law is full of loops and knots. This condition gives rise to consumer suspicion and to producer uncertainty. It does not make for business confidence, either for buyer or seller. Confidence is very much needed in business.

* * *

This magazine aims to represent the cement industry, not the cement producer, *or* the cement consumer, but the cement producer *and* the cement consumer. Their interests are not opposed; they are mutual. They are identical; they differ only in view*point*, not in the thing viewed.

If the quality of cement is poor it will come into disuse.

If the quality is high, its use will increase.

If the price is too high, its use will be discouraged.

If the price is too low, its manufacture will be discouraged.

What the producer must consider is the investment of very large capital in producing plants and the necessity of operating those plants as fully as possible to insure a profit. He, therefore, adopts means to encourage the use of cement; to increase its application to engineering work. In this present entanglement with the law, guilty or innocent, it will not satisfy the best interests of cement producers to get merely a technical acquittal. The interests of everybody will be served best by the re-establishment of public confidence. A technical acquittal ought, under the principles of our system of jurisprudence, to be enough, but it probably would not be enough to accomplish what the cement producers desire to accomplish. It is therefore to be hoped that the cement producers will let all possible light in on their business to correct if they can the false notions—if they be false—which many cement consumers have in their minds. The cement man should not overlook the fact that confidence cannot be restored if the consumer reasons in some such fashion as this:

> There are only about 120 cement manufacturing plants in the United States. They have never operated at 100% capacity. Some plants are idle over long periods. Some have been operated at a loss over considerable periods. Some plants make cement more economically than other plants. If only the efficient producing plants were operating, and those at full capacity, cement could be sold at a profit at less cost to the consumer. The public has the right to feel that it should not pay to support an inefficient enterprise. It resents the fact, therefore, that while cement is manifestly not produced at a uniform cost per barrel, it is usually sold at a uniform price per barrel, and the public probably has good reason to believe that this selling price is not established on the minimum of profitable production cost in the efficient plants.
>
> Can the public be blamed that it suspects very strongly that free competitive conditions do not exist in a market where bids are practically identical from producers variously efficient and inefficient, and at various distances from the point of distribution?
>
> A contractor "fires" an inefficient workman. Must he pay to support variously efficient producers of his materials?
>
> It is the same trouble in many phases throughout industry. The employers struggle to upset those weaknesses of trades unionism which have fixed standards based not upon efficient service, but upon the performance of the inefficient.

* * *

It is to be hoped that if cement producers are found to have got their heads together to gouge the cement consumer, they will be so punished as to discourage the practice in the future.

If, on the other hand, their innocence of any such illegal connivance is established, it is hoped that the conditions of the cement business will be so clearly brought out at the trial in New York that not only the presiding judge and the jury, but the general public may see just what the conditions are and thus eliminate the suspicions that act as a brake upon business.

Producers of basic commodities for general use, such as cement, will do well to let the light in, as much as they can, on their industries. The public likes fair play. It begrudges nobody a decent profit for service performed. The cement industry needs light on its affairs; then things will correct themselves, if they need correction.

There should also be such a clarifying and simplifying of public laws that the course of business will be plain. There should be laws to protect, not only the public against profiteering and suppression of competition, but to protect business from the undermining influences of business wreckers who ignorantly or piratically sell their goods at a loss.

The laborer is worthy of his hire.

A Gunite House in Pasadena

These pictures are of the Paxton residence, Orange Grove avenue and State street, Pasadena, Cal., Reginald D. Johnson, architect.

The building is veneered with reinforced gunite. J. C. Hain, of the Los Angeles Cement Gun Co., which did the work, says:

"We first put on a 15 lb. felt, then over this a 12 gauge reinforcing mesh, blowing on a gunite base coat. The finish coat on this particular job was put on by hand and is more or less irregular in texture, in representation of an old Spanish residence. We not infrequently apply a gun finish coat, but this texture cannot be varied and it has other disadvantages. Some of the buildings we do have the gunite base coat rodded true, in which case we generally apply a floated hand finish coat, or true it up the same as the inside of a building. One reason our work appeals to architects is because we give them anything they desire."

The Trial of Eastern Cement Manufacturers

An Unadorned Summary of Court Proceedings Up To the End of April

By Edwin C. Eckel
Special Representative of "Concrete" at the Trial

Edwin C. Eckel, a Consulting Engineer in Washington, D. C., was engaged by Concrete to report the cement trial because of the belief that he was the best man to do the job with unswerving impartiality, and with the necessary background of knowledge of the cement manufacturing field. He was formerly with the U. S. Geological Survey; is the author of works of recognized standing on cement; during the war he had a great deal to do with the organization and equipment of cement plants in France for the United States forces and our allies on the Western Front. He is an Associate Member, Am. Society of Civil Engineers; member Society of Chemical Industry; Major, Engineers, U. S. R.

The case of *The United States vs. The Atlas Portland Cement Company et al.*, in the Federal Court for the Southern District of New York, before Judge Knox and a jury, had its opening session April 4, 1922. The sessions of April 4, 5, and 6 were occupied with the selection of a jury, the presentation of several formal motions by counsel, and the opening statements on behalf of the government and the defendants. With the session of April 7 the first witness was put on the stand by the government, and at subsequent sessions the government case has been presented. It is still in course of presentation at the date of this writing, so that it is impracticable as yet to summarize the case for the prosecution in its entirety.

The case for the government is presented by Messrs. William Hayward (United States attorney), James A. Fowler, Roger Shale, and Oliver E. Pagan (special assistants to the Attorney General). For the defendants appear Messrs. Henry L. Stimson, Archibald Cox, George T. Buckingham, Joseph Cotton, Louis H. Porter, Goldthwaite H. Dorr, Kenneth M. Spence, Thurlow M. Gordon and Leland B. Garretson.

In order that the progress of the case may be followed understandingly, so that its final bearings can be understood whenever a decision is reached, each stage in the matter will be stated as simply as possible. It may be noted that wherever quotation marks are used in this account of the case, the quotation is taken verbatim from official transcripts of the record, as I do not care to rely upon my own notes in a case of such importance and interest to the industrial and business world.

The Defendants in the Case

The defendants in the case include 19 corporations and 44 individuals, the corporations being those which were members of the Cement Manufacturers Protective Association, while the individuals were officials and agents of the different defendant corporations.

The corporations appearing as defendants are the Atlas, Allentown, Alpha, Bath, Coplay, Dexter, Edison, Giant, Glens Falls, Hercules, Knickerbocker, Lawrence, Lehigh, Nazareth, Penn-Allen, Pennsylvania, Phoenix, Security, and Vulcanite cement companies.

The officials and agents of these companies who appear individually as defendants are respectively Messrs. J. R. Morron, W. E. Miner, J. L. Medler, W. A. Holman, L. R. Burch, D. H. Macfarland, J. T. Phelan, G. S. Brown, F. M. Coogan, J. J. Matthes, W. G. Dutton, F. P. Hahnemann, F. L. Loeb, G. A. Christ, J. F. Twamley, J. Brobston, R. W. Hilles, W. D. Cloos, J. C. La Rue, R. E. Griffith, F. J. Jiggens, S. N. Peters, G. F. Bayle, Sr., G. F. Bayle, Jr., M. Kind, E. B. Goode, Jr., A. D. Naylor, W. M. Floring, M. S. Ackerman, F. H. Smith, E. M. Young, A. F. Walter, B. L. Swett, J. A. Horner, W. E. Erdell, T. O. Bretherton, W. N. Beach, E. P. Alker, L. C. Morton, C. H. Cox, L. A. Cover, J. B. Lober, W. D. Lober, and A. Moyer.

Summary of the Indictment in the Case

On August 8, 1921, a Federal grand jury filed indictments against the corporate and personal defendants above named. In summarizing these charges I have retained the exact original wording, but have eliminated the unnecessary verbiage. The grand jury found that the defendants had, during the period from August 10, 1918, to the day of indictment, unlawfully engaged in a combination in restraint of interstate trade and commerce in cement, carrying on such trade "without any competition between any of the corporate defendants, as to discounts, as to charges for bags, as to credit allowances for bags returned, as to charges for bin tests, as to the prices at which they have so sold and shipped such cement, or as to customer dealers to whom they have so sold and shipped the same; and under these circumstances have so sold and shipped cement at arbitrary, non-competitive and excessive prices, and in quantities fixed by agreement among said defendants from time to time."

The grand jury further found that, as a means of securing compliance with the terms of these agreements and understandings, the "Eddy plan of open competition" was adopted, under which each of the corporate defendants made to the Cement Manufacturers Protective Association, "of which said corporate defendants were the only members, dteailed daily, monthly, and special reports of all current and completed transactions pertaining to its business," which reports were summarized by the C. M. P. A., and the summaries were promptly sent to each corporate defendant, "so that each of said corporate defendants . . . has had full information as to the business . . . of all other corporate defendants."

The second count of the indictment charges that the mere adoption of the Eddy plan on August 10, 1918, was essentially a contract in restraint of interstate trade and commerce, "in that the natural and inevitable effect of such adoption and following of said plan, as said defendants each then and there well knew and intended, would be to eliminate all competition between said corporate defendants" with regard to the items covered.

The criminal suit now under trial is the result of these indictments. Their bearing and implications are brought out more clearly if we consider the opening statement to the jury by counsel for the Government, which was made on April 6.

The Opening Statement for the Government

Mr. Shale, in opening for the Government, commenced by outlining certain broad features of the manufacture of portland cement, and of the history of the industry in this country. This preliminary portion of the statement needs no summary here, since it covers ground entirely familiar to the readers of Concrete, though of course unfamiliar to the average juryman. After calling attention to the general bearing of the Sherman anti-trust act, Mr. Shale concentrated attention upon the particular case in court. In outlining the case to be presented by the Government, the following points are noteworthy as indicating what the Government will attempt to prove:

"We will show you that for several years there has been no semblance of competition between the defendants in this case in the manufacture, sale and distribution of portland cement. The unmistakable tendency of their conversations, as recorded in the minutes of meetings which have been held; the correspondence and reports which have been exchanged throughout a period of years, shows what we claim is a tendency to eliminate competition."

"In the latter part of 1902 representatives of 23 companies engaged in the manufacture of portland cement called a meeting and organized the Association of American Portland Cement Manufacturers. . . . Eleven of the corporate defendants in this case participated in the organization of this original association. . . . We will show you the nature of the matters which were discussed from time to time. . . . Curtailment of production was freely and openly discussed and advocated as an effective means of assuring higher prices. . . . Uniform cost accounting systems were frequently advocated. . . . In 1916 the association adopted, published in pamphlet form, and distributed to its members 24 so-called trade practices. . . . It is the contention of the Government that these trade practices show clearly a purpose to eliminate competition with respect to many important items affecting the sale and distribution of portland cement."

"In 1908 certain of the defendant corporations caused to be organized the North American Portland Cement Co. . . . During the period from about 1908 to 1911 ten of the defendants were organized together as members of the Association of Licensed Cement Manufacturers. This was dissolved by consent of its members in 1911. . . . In the latter part of 1913 a number of the defendants organized what they designated as the Eastern Cement Association. This was maintained for a period of only three or four months. . . . This brings us down to the organization of the Cement Manufacturers Protective Association, which is or was in existence at the time this indictment was returned. . . . The Government contends that this Association is the principal instrumentality through which or behind which—because it is nothing more nor less than a smoke screen—the defendants have conspired to eliminate competition."

"The minutes of the meetings of these associations will be introduced in evidence. . . . They will show that the discount to be allowed was frequently discussed. . . . Production capacity of the mills of member companies was frequently discussed, and adroitly discussed in such a manner that it was not necessary openly to advocate curtailment of production. The employment of a force of checkers or inspectors, to investigate contracts, was discussed. . . . The diversion of cement from one job to another was discouraged, except on condition that the contractor pay the prevailing price if there had been an increase in price in the meantime. The importance of adopting a uniform cost accounting system was discussed. . . . The credit to be allowed for bags returned was openly discussed. . . . The subject of trade relations or trade practices was discussed, and determined to be within the province of the Portland Cement Association."

Govt. Ex. No. 3.

PENNSYLVANIA

	Universal	Union Bridge	Lehigh Valley
Aberdeen	53	43	45
Abrams	53	43	37
Academy	53	43	41
Academy Corners	49	49	49
Ache Junction	35	49	53
Acheson	25	49	53
Ackermanville	61	53	22
Acorn	53	43	37
Acosta	35	49	51
Adah	35	49	53
Adams (Somerset Co.)	35	49	51
Adamsdale	53	45	37
Adamsville	37	55	59
Adelaide	33	49	53
Ajax	41	49	53
Akeley	43	49	53
Akron	53	43	39
Aladdin	27	49	53
Alba	49	49	43
Albany	53	49	39
Albert	53		37
Albion	37	55	59
Alburtis	53	49	31
Alden	53	49	37
Alderson	53	51	41
Aldham	53	43	45

[The balance of this Exhibit, which contains one hundred and thirty-five (135) pages, will not be printed by order of the Court.]

Fig. 1—Sheet from Freight Rate Book Issued by Cement Manufacturers Protective Association—Placed in Evidence as Government Exhibit in Trial of Cement Manufacturers

"The Cement Manufacturers Protective Association uses aproximately thirty forms of reports in connection with the collection, compilation, and distribution of statistical data. . . . It is the contention of the Government that it is not possible for anything resembling competition to exist between men who have such comprehensive information as to every detail of the business of their potential competitors. . . . We will show you that there is a capacity among the companies belonging to this association to produce 40 to 45 million barrels a year, and we will show you that they have never produced to their capacity, either individually or collectively. . . . We will show you that the price of cement, during the years 1920 and 1921, reached an unconscionable figure."

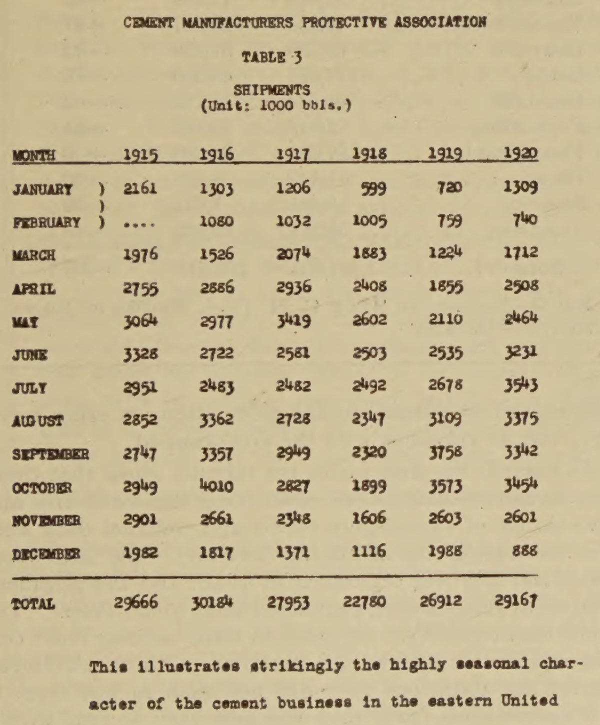
In considering the five paragraphs immediately preceding, the reader will do well to bear in mind that the quoted statements there made *do not represent facts already fully proven,* but that they are merely statements of what the Government hopes to prove by testimony to be offered in the course of the present trial.

THE OPENING STATEMENT FOR THE DEFENSE

In opening for the defense, Colonel Stimson noted at the outset the difficulty in refuting charges carried back over a period of twenty years:

"The Government is going back to things which they cannot ask you to condemn these men for, because it would be against the law. But they are going to say that they were an early germ of this conspiracy, for which they are prosecuting us, and that they have a right to follow back that germ to 1902. You can see that puts an enormous burden on us. The purpose of having a statute of limitations is because it is very hard for a man who is accused of doing something twenty years back to show exactly the situation that existed then, and it is still harder if he was not the man that did it twenty years ago. The Government admits that only 11 of the 19 defendant corporations were in business in 1902, and they have also stated that only two of the 44 individual defendants were in the cement business at that time at all."

Colonel Stimson further stated that it would be shown that the defendant companies did not divide territory, or pro-rate their business, or pool earnings; and suggested that if there were really a suppression of competition, one of these three alternative methods must have been adopted.



CEMENT MANUFACTURERS PROTECTIVE ASSOCIATION

TABLE 3

SHIPMENTS
(Unit: 1000 bbls.)

MONTH	1915	1916	1917	1918	1919	1920
JANUARY)	2161	1303	1206	599	720	1309
FEBRUARY)	....	1080	1032	1005	759	740
MARCH	1976	1526	2074	1883	1224	1712
APRIL	2755	2886	2936	2408	1855	2508
MAY	3064	2977	3419	2602	2110	2464
JUNE	3328	2722	2581	2503	2535	3231
JULY	2951	2483	2482	2492	2678	3543
AUGUST	2852	3362	2728	2347	3109	3375
SEPTEMBER	2747	3357	2949	2320	3758	3342
OCTOBER	2949	4010	2827	1899	3573	3454
NOVEMBER	2901	2661	2348	1606	2603	2601
DECEMBER	1982	1817	1371	1116	1988	888
TOTAL	29666	30184	27953	22780	26912	29167

This illustrates strikingly the highly seasonal character of the cement business in the eastern United

FIG. 2—THIS EXHIBIT AT THE TRIAL SHOWS STRIKINGLY THE HIGHLY SEASONAL CHARACTER OF THE CEMENT BUSINESS IN THE EAST

Finally, he pointed out that in the course of the trial there were five points that would be clearly established by the defense. These were (1) the presence of competition, (2) a moderate rate of profits, (3) prices that had not risen as fast as those of other commodities, (4) the formation of an association for the improvement of business conditions, and (5) constant publicity of all actions, with regard to the Government itself.

It is probably unnecessary to note that the remark made relating to the opening statement for the Government holds true with regard to that for the defense. The assertions made must be considered as only possibilities until they are fully proven in the course of this case.

THE PROGRESS OF THE CASE

In following out the course of the trial, the testimony offered will be grouped so far as possible by subjects. This necessitates some rearrangement as to dates, but it puts the proof in more logical order and will be easier for the reader to follow.

CEMENT MANUFACTURERS PROTECTIVE ASSOCIATION
MONTHLY SUMMARY OF CONTRACTS FOR FIRST NINE MONTHS 1920

Company	New Contracts No. to Date	New Contracts Bbls. to Date	Cancelled Contracts No. to Date	Cancelled Contracts Bbls. to Date	Reinstatements & Increases to Date	Decreases to Date
Allentown	196	549,390	168	307,197	19,638	99,788
Alpha	552	1,944,794	604	742,958	67,570	80,238
Atlas	827	2,826,078	699	881,120	78,934	443,039
Bath	72	178,200	147	214,764	800	9,671
Coplay	218	495,706	195	305,206	10,101	42,157
Dexter	289	587,968	126	204,502	4,700	18,219
Edison	140	622,927	287	504,860	40,142	194,653
Giant	113	576,729	92	183,621	2,812	95,557
Hercules	361	586,887	344	339,375	6,138	73,535
Knickerbocker	233	723,881	64	176,767	3,500	44,803
Lawrence	310	1,273,443	144	290,558	23,269	95,190
Lehigh	775	2,219,209	841	1,031,852	81,697	113,892
Nazareth	238	1,041,971	188	339,119	12,138	15,850
Penn Allen	107	222,465	113	172,784	17,750	58,820
Pennsylvania	239	914,000	71	320,921	27,553	3,000
Phoenix	69	223,680	137	351,092	4,614	7,442
Vulcanite	281	630,735	293	310,575	13,457	143,591
Total	5,020	15,618,063	4,513	6,677,271	414,813	1,539,445
		414,813		1,539,445		
		16,032,876		8,216,716		

FIG. 3—GOVERNMENT EXHIBIT SHOWING C. M. P. A. SUMMARY OF CONTRACTS

Of the witnesses so far placed on the stand by the Government, one was so presented in order to establish facts concerning the organization and functioning of the Cement Manufacturers Protective Association; one was presented to testify directly as to certain acts of the defendants, and eleven were used to establish facts as to trade conditions and practices at various periods. But in addition, the Government also read into the record extracts from the minutes of the C. M. P. A. from 1916 to 1921. In summarizing this mass of testimony, which on April 21 already amounted to some 2,000 printed pages, it will be clearest if we take up first the mechanism of the C. M. P. A., then its recorded proceedings, then the facts as to trade conditions—and finally the attempt at a direct proof of criminality.

But before doing this, an admonition by Judge Knox to the jury, delivered on April 17, has a direct bearing on the case. It was as follows:

"I want to caution you again against reading any articles that appear in newspapers or magazines having to do with the legality or illegality of trade associations. When this issue comes to be delivered to you, it is to be determined upon the facts that are adduced in the course of the trial, and upon the law as I shall give it to you, and I think it very desirable from the standpoint of the Government and of the defendants that your minds be not confused with any conflicting ideas or viewpoints that may from time to time be expressed in the public press by persons who are interested in one side or the other of the general topic of trade associations."

The second count in the indictment, it will be recalled, involves a law point based upon the subject referred to in the admonition.

THE MECHANISM OF THE CEMENT MANUFACTURERES PROTECTIVE ASSOCIATION

Miss M. B. Phalen, secretary of the Cement Manufacturers Protective Association from May, 1918, to date, was placed on the stand by the Government on April 7, and her testimony also occupied the entire session of April 10. It was made the medium for introduction, by both Government and defense, of a vast mass of printed forms, records and other documentary evidence. Out of the four or five hundred pages relating to this subject, it is possible to select a few points of importance and general interest as follows:

The constitution of the C. M. P. A., put in evidence by the Government, provides that any corporation, firm or individual engaged in portland cement manufacture shall be eligible for membership; that elections are by majority vote, and that withdrawal is voluntary. The objects of the Association are stated as below:

"The collection and dissemination of such accurate information as may serve to protect each manufacturer against misrepresentation, deception and imposition, and enable him to conduct his business exactly as he pleases in every respect and particular, free from misdirection by false or insufficient information concerning the matters following:

"(a) Information concerning credits.

"(b) Information concerning contracts which have been made for the delivery of cement, sufficiently complete to enable the manufacturer to protect himself against spurious contracts and like transactions induced by misrepresentation.

This Form for Correspondence Between Offices
and Factories Only

THE ATLAS PORTLAND CEMENT CO.
New York

Subject June shipments.	For the Attention of Mr. Holman, Mr. Office.

New York, July 13th, 1918.

I want to draw your attention to the fact that the Lehigh shipped 373,000 out of the east, against our 414,000, which is a very bad showing for us. Of course I realize what they did last year and all that, but what I mean to say is that they are shipping very nearly as much stuff now out of their Lehigh Valley mills as we do.

They also did a wonderful business in Mitchell, New Castle, Mason City and Oglesby. I do not think we can afford to go to sleep much.

The Universal also put a few circles around us, and about the only thing we can compare favorably with for June, as far as I can see, is the Alpha.

Now I understand that MacFarland will say that if we had had more orders we could not have shipped them. What I am getting at, however, is to get more orders, and I will agree to ship them, and it looks as though we were going to have enough to justify it.

Yours truly,

J R M

FIG. 4—EXHIBIT BY DEFENSE TO PROVE THAT VERY ACTIVE COMPETITION EXISTED AMONG MEMBER COMPANIES—J. R. M. IS J. R. MORRON, PRESIDENT OF THE ATLAS COMPANY

"(c) Information concerning freight rates on cement.

"(d) Statistical information as to production, stocks of cement and clinker on hand, and shipments."

The testimony of Miss Phalen, on direct and cross-examination, showed the methods by which the C. M. P. A. carried out these objects. Actual records as of various dates exemplified these methods in detail.

THE PROCEEDINGS OF THE C. M. P. A.

Following the testimony of Miss Phalen, the Government read into the record extracts from the minutes of various meetings of the C. M. P. A., several days being occupied by these readings. The extracts read included a large number of records of roll-calls, a large amount of casual conversation on various subjects connected with the activities of the Association, and a few points which may be of general interest. The only two which seem worth recording here are the relations of the C. M. P. A. with regard to certain similar associations in other territory, and its relations with the Government.

CEMENT MANUFACTURERS PROTECTIVE ASSOCIATION

SHIPMENTS

December 1st, 1920 to December 15th, 1920.

Company	*1919*	*1920*	*Change Per Cent*
Allentown	18,624	9,719	—48
Alpha	112,327	29,843	—73
Atlas	306,006	125,828	—59
Bath	32,536	9,307	—71
Cayuga	8,422	13,419	+59
Coplay	46,612	22,832	—51
Dexter	22,449	20,529	— 9
Edison	35,259	10,748	—70
Giant	44,366	19,204	—57
Glens Falls	12,491	1,938	—84
Hercules	21,374	11,058	—48
Knickerbocker	16,853	24,857	+47
Lawrence	63,739	37,138	—42
Lehigh	178,683	43,000	—76
Nazareth	40,644	15,122	—63
Penn Allen	27,812	10,142	—64
Pennsylvania	57,492	61,099	+ 6
Phoenix	11,149	8,863	—20
Security	18,445	7,611	—59
Vulcanite	56,321	19,262	—66
Total	1,131,604	501,519	—56

FIG. 5—EXHIBIT TO SHOW C. M. P. A. RECORD OF SHIPMENTS OF CEMENT

As regards the first point, the minutes show that there were numerous discussions concerning the feasibility and advisability of exchanging credit and contract data with two associations in adjoining territory—the Mid-West Statistical Bureau, organized in 1916, and the Southern Statistical Association, organized some years later. The problems involved do not seem to have been serious; certain companies which had markets in these territories desired the data, but they did not wish to pay dues to two associations, and they did not care to put in the work necessary on two sets of reports. Committees appointed to consider these matters seem to have smoothed out these points, and an interchange of credit and contract data with the Mid-West Bureau seems to have been put into effect. The extracts read did not, however, clear up the Southern question. In all of these operations and discussions there is constant reference, in the extracts read from the minutes, to the legal limitations of the work, and advice of counsel was asked and given with great frequency.

As regard the second point, there are a number of references in the minutes to conferences with representa-

(Continued on Page 220)

How to Make Forms for Concrete Buildings —*Beams and Girders*

The Fourth Article of an Important Series Written for the Builder Who Wants to Know the Subject From the Beginning

By William F. Lockhardt
Lockhardt-Byrne Co., Inc.
New York City

> The literature of form work is scanty. It especially fails to meet the needs of builders who are obliged to begin at the beginning to study the subject. Contractors and superintendents have repeatedly asked Concrete to publish articles whose authors would not take it for granted that their readers already knew most of the subject. The editors cast about for the right man to prepare such articles, and were fortunate in getting the promise of William F. Lockhardt to do the job. Articles on forms for Footings, Columns, and Walls have been published in three previous issues. The series will be continued. Mr. Lockhardt's descriptions of form work are based on the actual practice of some of the most successful concrete building contractors in the United States. Various methods have been tried, and these methods have survived. If any reader is in doubt about some step in form building, when he has read Mr. Lockhardt's article on any one of the special subjects in the series, he will be conferring a favor on the editors and on many readers if he will ask to have the point more fully explained. A reader who has used form building methods different from the methods here described, and which he believes better for any reason whatever, will be adding something to the consideration of a very important subject if he will describe those methods for this magazine.—The Editor.

An economical system of beam and girder forms for a building job really starts with the lumber list, on which should be shown clearly the manner in which the lumber is to be used. This will avoid confusion when the carpenter foreman starts the fabrication of forms, and if the lumber list shows, as it should, for just which member each particular piece of lumber has been ordered, very little extra material need be bought, and a great deal of waste can be avoided. Before the lumber list can be made up, however, a thorough knowledge is required of just how the forms are put together, so that as the plans are studied the necessary form details for each individual beam and girder can be clearly pictured mentally.

The methods used for stripping and reposting will also affect the quantity of lumber to be bought, so that it will be most convenient to consider the several phases of the work in turn, touching on the lumber sizes commonly used, with a few notes on safe carrying capacities, posting, stripping, and reshoring, form details and the lumber required and the lumber list itself.

The lumber used must be strong enough to contain and support the mass of semi-liquid concrete that it encloses, and in the case of beam sides and floor panels be stiff enough to hold its lines after it has been made up into forms, without sagging or bulging, or requiring an undue amount of battening or bracing to keep it true. The sizes given here have come to be accepted as standard by most large contractors, and for ordinary building work can be followed to advantage.

Shores and posts, usually 4 in. x 4 in. Rgh. Occasionally 6 in. x 6 in. for special cases of very heavy loads or stories too high for 4 in. x 4 in. posts.

Beam and Girder bottom, 2 in. x .... in. Dressed 4 Sides to 1¾ in. x *(required width)* in.

Beam and Girder sides, 1½ in. x .... in. Dressed 4 Sides to 1¼ in. x *(required width)* in.

Cleats or battens 1 in. x 4 in., 1¼ in. x 4 in. or 2 in. x 4 in. Rgh.

Ledgers 1¼ in. x 4 in. or 2 in. x 4 in. Rgh.

Spreaders 3 in. x 4 in. Rgh.

Floor Panels 1 in. x 6 in. Roofers, D 4 S to ⅞ in. x 5½ in. T. & G.

The first step when considering the general layout of the forms, before making up the lumber list, is to figure out the weight to be carried by the forms, and the resultant allowable spacing of the shores. The weight of the concrete is usually taken at about 150 lbs. per cu. ft. The following tables, taken from the *Cambria Handbook,* give the safe loads in pounds uniformly distributed, including the weight of the beam itself, for rectangular beams 1 in. thick. The safe load for a beam of any thickness may be found by multiplying the values given in the tables by the thickness of the beam in inches. It is well to bear in mind, however, that these tables are computed for sound structural timber, while much of the lumber entering into form work falls short of this quality. For additional safety, therefore, the values given should be somewhat reduced.

Span Ft.	Spruce									Short Leaf Yellow Pine								
	Depth of Beam in Inches																	
	4	5	6	7	8	9	10	11	12	4	5	6	7	8	9	10	11	12
1																		
2																		
3																		
4	311	486	700							444								
5	249	389	560	762	996					356	556							
6	207	324	467	635	830	1050	1296			296	463	667	907					
7	178	278	400	544	711	900	1111	1344	1600	254	397	571	778	1016				
8	156	243	350	476	622	788	972	1176	1400	222	347	500	681	889	1125			
9	138	216	311	423	553	700	864	1046	1244	198	309	444	605	790	1000	1235		
10	124	194	280	381	498	630	778	941	1120	178	278	400	544	711	900	1111	1344	1600
11	113	177	255	346	453	573	707	856	1018	162	253	364	495	646	818	1010	1222	1455
12	103	162	233	318	415	525	648	784	933	148	231	333	454	593	750	926	1120	1333
13	96	150	215	293	383	485	598	724	862	137	214	308	419	547	692	855	1034	1231
14	89	139	200	272	356	450	556	672	800	127	198	286	389	508	643	794	960	1143
15	83	130	187	254	332	420	519	627	747	119	185	267	363	474	600	741	896	1067
16	78	122	175	238	311	394	486	588	700	111	174	250	340	444	563	694	840	1000
17	73	114	165	224	293	371	458	554	659	105	163	235	320	418	529	654	791	941
18	69	108	156	212	277	350	432	523	622	99	154	222	302	395	500	617	747	889
19	65	102	147	201	262	332	409	495	589	94	146	211	287	374	474	585	708	842
20		97	140	191	249	315	389	471	560	89	139	200	272	356	450	556	672	800

Where it is necessary to shore up a beam or floor spanning an open shaft be sure that the timbers used are capable of carrying the load. For example, do not use a 3 in. plank to carry a 6 in. x 6 in. shore on a guess, but find out what load the shore is supporting, and then use a timber large enough to carry that load concentrated in the middle of the required span. If practicable from the standpoint of cost, the most satisfactory method is to use continuous shores to a solid bearing below. Sometimes an A frame of heavy timbers can be utilized to carry the load back to the section of the floor below that borders the shaft.

A very important factor in any posting is the story height. For example, the usual 4 in. x 4 in. shore, if 12 ft. long, will carry 3½ tons safely, but if the length is increased to 16 ft. it will only carry 1¾ tons safely. In high stories it may be advisable to use 6 in. x 6 in. shores, or else spike two 4 x 4's together. Single 4 x 4's over 12 ft. long, and 6 x 6's over 16 ft. long, should be cross-braced or stay-lathed in both directions at vertical intervals of six or seven feet. Where shores are stay-lathed do not use more than three-fourths of safe carrying capacity of the longest section between the stay-lathing, when consulting the tables. It must also be borne in mind that if stay-lathing is required for shores under forms, it is also required for the reshores.

Care should always be taken to cut shores square on the ends and to place them plumb, with a full bearing top and bottom. A post out of plumb will fail much sooner than a shore placed plumb. Spliced shores are an abomination from the standpoint of security, but cannot always be avoided. When it is necessary to splice a shore make sure that the abutting ends are square and that they get a full bearing. The two parts of the shore should line up, the cleats or scabs should be long enough, and properly nailed. It is always advisable to put cleats on all four sides of the shore. And again finally, see that the shore is set up plumb. While it is bad enough to put a whole shore up out of plumb, it is simply courting disaster to do it with a spliced shore.

The formula of the American Railway Engineering and Maintenace of Way Association for unseasoned short-leaf pine and spruce posts is as follows:

$$L = 1100 \times \left(1 - \frac{l}{60d}\right)$$

in which:

L=Safe load in pounds per square inch
l=Length of post, in inches
d=Least diameter of post, in inches
1100=Bending extreme fibre safe working stress.

The formula is intended for railroad bridges and trestles, and for other structures certain increases are allowed in loading, but as the lumber used for form work is often of a poor grade it is advisable to adhere to the values given by the formula. For convenience a table of values computed for 4 in. x 4 in. and 6 in. x 6 in. posts is given herewith, based on this formula:

Spruce or Short-Leaf Yellow Pine

Length in Feet	Least Diameter of Post in Inches	
	4	6
6	12,300 lbs.	31,600 lbs.
8	10,500 lbs.	29,000 lbs.
10	8,800 lbs.	26,400 lbs.
12	7,000 lbs.	23,800 lbs.
14	5,200 lbs.	21,100 lbs.
16	3,500 lbs.	18,500 lbs.
18	1,700 lbs.	15,800 lbs.
20	No value	13,200 lbs.

Because of the speed with which concrete buildings are ordinarily erected the dead load of the next story is frequently placed on concrete scarcely a week old, when we know that it has only a part of its ultimate strength. This means that to carry the successive stories as they are erected there should always be at least two stories fully reposted (in addition to the shores under the forms) and one additional story partly reposted. This story should have at least half the reshores in place. This is shown in Fig. 1 which is a vertical section through a typical bay of a building. These rules apply to summer or warm weather work carried on at the rate of about a story per week. For winter work or greater speed at least one additional story fully reshored is required, and sometimes more, depending upon the individual job conditions.

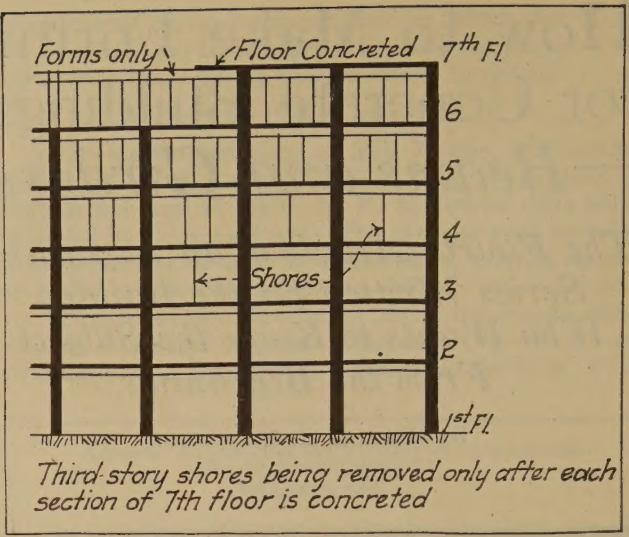

Forms only
Floor Concreted
7th Fl
6
5
4
3
2
1st Fl
Shores
Third-story shores being removed only after each section of 7th floor is concreted

Fig. 1—Typical Arrangement of Re-shores—Concrete Is Between Three and Four Weeks Old Before All the Re-shores are Removed

A safe stripping schedule is as follows, based on summer conditions:

1. Columns, 24 hours after floor slab is placed.
2. Girders, 60 hours after concreting (third day).
3. Beams, 84 hours after concreting (fourth day).
4. Panels any time after the beams.

The perspective sketch Fig. 2 gives a good idea of the general arrangement of beam and girder forms. The girder forms span between the columns, and are generally supported by blocking up from the top column yoke. If metal column forms are used, the girders are supported by a scaffold or bent similar to that shown last month in the article on "Column Forms." The beam forms are carried by the girder forms, generally by spiking a piece of 2 x 4 to the outside of the girder form just below the beam opening. The floor panels are made up with 3 in. x 4 in. spreaders on the back in place of battens. These spreaders rest on a 1¼ in. x 4 in. ledger nailed to the cleats on the outside of the beam form. This shows very plainly in Fig. 3A which shows the carpenters about to lower a floor panel into place. The ledger can be seen very plainly just below the lower ends of the spreaders, which happen in this case to be 2 x 6's. A 3 in. x 4 in. spreader will not carry as great

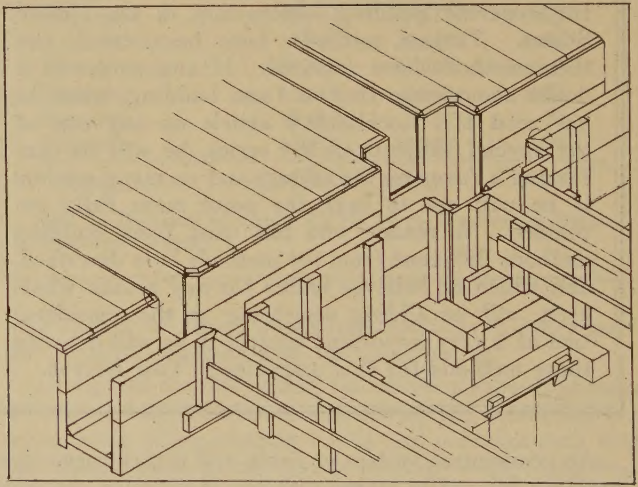


Fig. 2—Perspective of Beam and Girder Assembly at Column

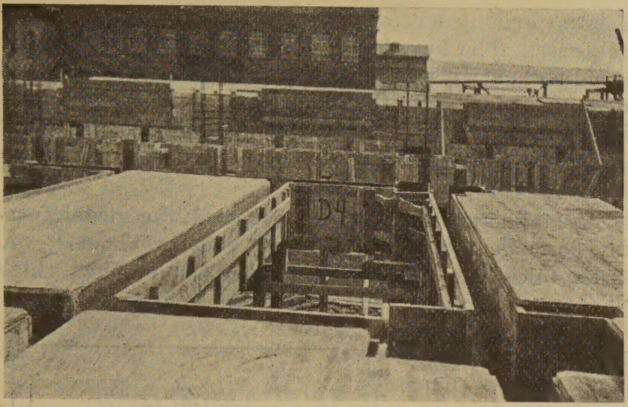


Fig. 3—Beam and Girder Forms in Place Before Panel Is Put Down

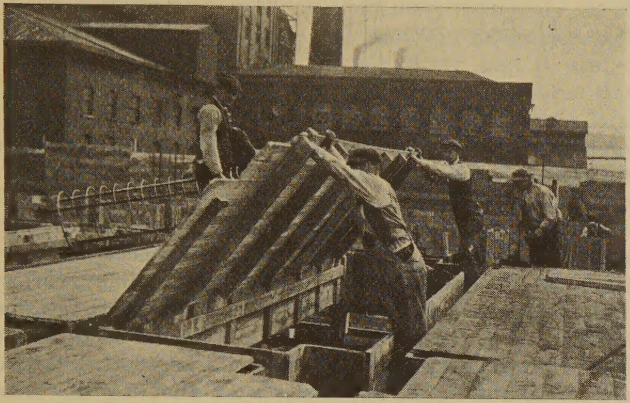


Fig. 3A—Putting Floor Panel in Place in Beam and Girder Construction

a load as a 2 x 6, but the number of spreaders is usually fixed by the allowable span for the 7/8 boards of which the panel is made, and this is 2 ft. 6 in. or less. Under these conditions, for the usual 4 or 4½ in. slab found in building construction, spanning about six feet between beams, a 3 x 4 spreader is strong enough, and it has the additional advantage that it does not overturn in handling or under load as readily as a 2 x 6.

It should be obvious then, that all parts of the system must be cut and framed to the right sizes to avoid patching out when the floor forms are being assembled in place; it should be equally obvious that if the various members comprising the form system are to be taken down economically, so that they can be used again, without having to cut and saw, proper clearances must be provided where the different members frame into one another. Some simple means must also be provided for closing up the gaps required for the clearances.

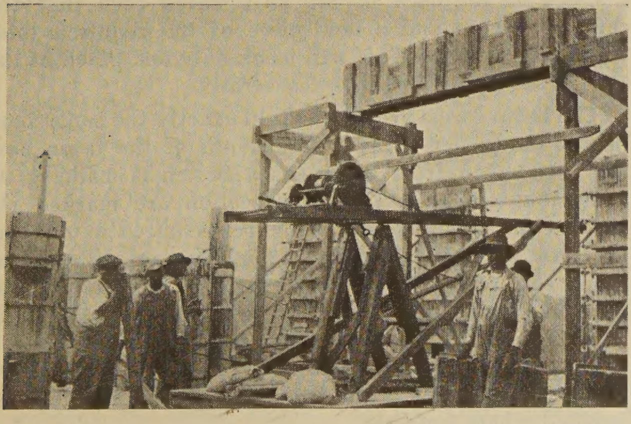


Fig. 4—Column Bents Set Up With One Girder Form in Place

The first member to go into place is of course the column, where wood column forms are used, because the column forms can then be made to carry the girders. Where metal column-forms are used the trestle or bent previously mentioned will be necessary to carry the girders. Fig. 4 shows a pair of such bents in position with the girder form roughly set in place on them. The required height for the bent is obtained as follows: Make a rough sketch similar to Fig. 5, putting down first the story height and then the distance from the finished upper floor surface to the under side of the girder forms. Note that this is not the underside of the concrete girder, it is the underside of the girder forms. This dimension is given for example in the drawing as 2 ft. 2⅞ in. and reference to Fig. 6 will show how this dimension is obtained. If the story height is 14 ft. from finished floor to finished floor we will have to first subtract the 26⅞ in. and then make some allowance for wedging under the bent to compensate for uneven spots in the floors. We will allow say 3⅛ in., thus making the height of the bent itself overall 11 ft. 6 in. This will work all

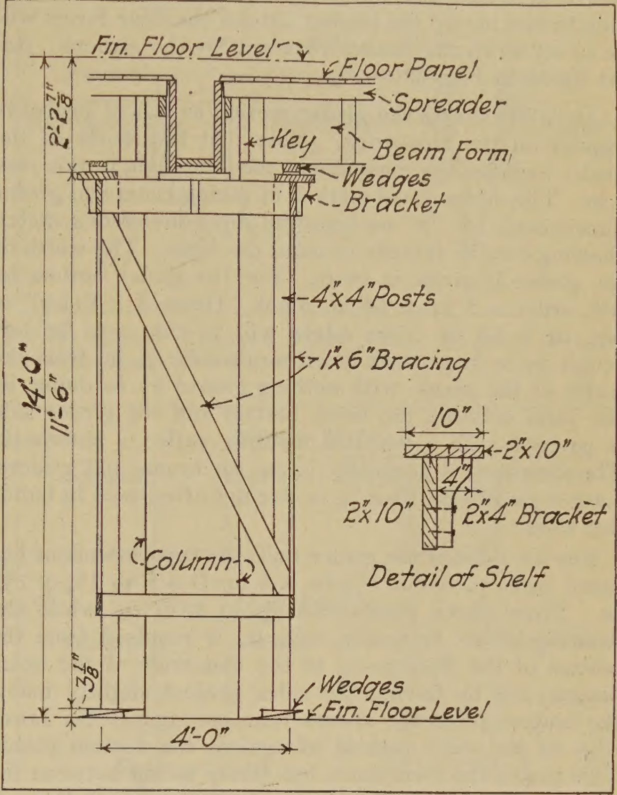


Fig. 5—Column Bent with Beam and Girder Forms in Place

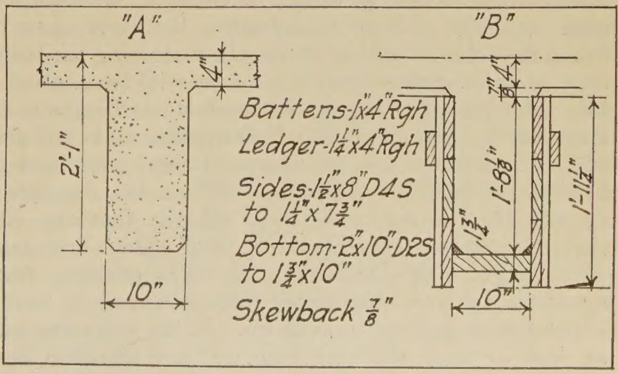


Fig. 6—Details of Typical Beam or Girder Form—(Girder Form Does Not Require the Ledger)

right where all, or nearly all, of the girders are of the same depth. Where the girders are of varying depths it would be inconvenient and expensive to make individual bents for each particular case, so that it is usual to make the bents low enough to take the deepest girders that are typical, and provide a shelf as shown in Fig. 5 upon which to wedge and block the shallow girders to the right elevation.

From this point on it will be an advantage to consider the form details and the lumber list together. The first step in making up the lumber list for the floor forms will be to set down the lumber required for the girders. Refer again to Fig. 6.

At "a" is shown the girder section as it will probably appear on the blue-print. Note that the depth of the girder includes the thickness of the floor slab, in this case 4 in. This is the usual method of giving beam and girder dimensions. At "b" we have the superintendent's sketch showing how he intends to build the form. The width of the girder is given as 10 in. For the girder bottom he will order a 2 in. x 10 in. plank "Dressed 2 Sides" to 1¾ in. x 10 in. The edges will in this case be left rough, as to dress them down would take ¼ in. from the width of the plank, with nothing gained by so doing, as the joint between the beam bottom and the girder side is covered with a bevelled molding called a skewback. The skewback is generally ⅞ in. for beams and girders. Larger skewbacks than ⅞ in. are not often used in building work.

For the sides of the girder form the superintendent has noted three pieces of 1½ in. x 8 in. D 4 S to 1¼ x 7¾ in. These three pieces add up to 23¼ in. while the drawing shows that only 21⅞ in. is required from the bottom of the floor panel to the underside of the beam bottom, but by having the sides project slightly below the bottom piece the shores bear up against the lower edge of the sides instead of against the bottom plank. This makes the form much less likely to sag between the shores and gives better lines. It is important that all beam and girder-side lumber be dressed to exactly the same thickness (1¼ in. or 1¾ in.) as it will be impossible to get a good looking job of concrete if some of the plank in the form are finished in ⅜ in. thick and others 1⅛ in. or 1¼ in. A note should always be made on the order for the lumber for beams and girders that all the material of a given thickness must be dressed uniformly to that dimension.

The length of the girder form will be somewhat less than the clear span between the concrete columns. In ordering the lumber it must be borne in mind that the girder will first be used between the columns in the basement or first story. Here the columns will have the greatest diameter and the girder form will consequently be shortest. If the drawing gives the length of the bay as say 20 ft. center to center of columns, with the columns assumed as 2 ft. in diameter, the clear span between the columns will be 18 ft. In discussing the length of a beam or girder form it may be well to mention at this point that the "length" of the form will refer to the length of the bottom plank. It is usual to make the sides of the form about 1½ in. shorter at each end than the bottom, to facilitate stripping. When the concrete is poured the pressure will force all the abutting form surfaces tightly together. If the sides are made full length, the pressure of the column forms against the ends of the girder form will make it next to impossible to get the form down. If the sides are made an inch or more short at each end a removable "key" piece may be inserted as shown in Fig. 7, which shows the condition at the junction of column and girder forms, or beam and girder forms, the details being similar in each case. The key, being bevelled, can usually be removed without difficulty, but if it sticks, it can be chopped out without injury to the main form, thus providing the clearance required. The bottom form may be made practically full length, as clearance is provided as soon as one end is pried down.

If metal column forms are to be used, the girder form may be made the full 18 ft. long, lacking about ¼ in. for the thickness of the metal in the column molds, which will be nailed to the ends of the girder forms.

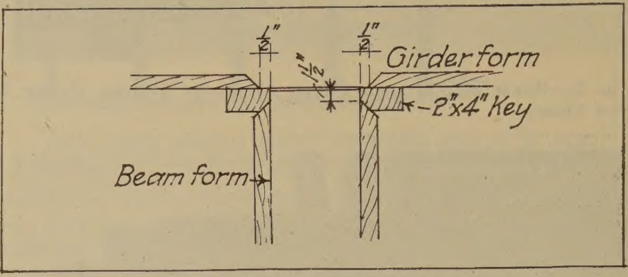


Fig. 7—Detail at Junction of Beam and Girder; or Beam or Girder and Column

When a wood column form is used, the length is figured in exactly the same way, taking into account, however, the thickness of the wood in the column forms, these being generally built of ⅞ in. lumber for interior columns. For the same case as we have assumed before the length of the girder bottom would be 18 ft. less two thicknesses of ⅞ in. material, or 17 ft. 10¼ in. The sides of course will be 3 in. shorter than the bottom, to allow the 1½ in. at each end for keying, thus making the hides 17 ft. 7¼ in. long.

The ends of the girder sides are cut on a 45° bevel as shown in Fig. 7. This drawing also shows the opening in column capital or girder, as the case may be, which is cut on a bevel the other way. The opening in the column is made 1 in. greater than the width and ½ in. greater than the depth of the beam. When the form is stripped this will show up as a narrow raised molding ½ in. wide around the end of the girder which is of value in making less conspicuous any minor irregularities that may occur in fitting the members together. Where wood column forms are used it is advisable to set the top column yoke at such an elevation that it will carry the girder at the proper height.

As the columns reduce in diameter from story to story it will be necessary to lengthen out the girder forms. This can easily be done by lightly nailing in place a piece of beam side material of the right width each time the column reduces. Or if the patch is fastened on with a splice on the back, it can be removed each time the column reduces and a new piece of the required total width substituted. This will mean only one patch at the end of the girder instead of several.

The beam forms are made up in exactly the same manner as the girder forms. The depth of the beam having been taken from the plans a sketch is made up to show the section and on this section are marked the sizes of the various pieces of lumber required to make up the form. It will always cost slightly more to make up a form of several pieces of 6 in. or 8 in. lumber than a lesser number of 10 in. or 12 in. pieces, but the slight difference in labor cost is more than offset by the difference in the cost of material, the 10 in. and 12 in. lumber being much more expensive, and therefore to be avoided where possible.

Cleats or battens are required on beams and girders to hold together the various pieces of lumber of which the form is built. These battens are 1 in. x 4 in. or 1¼ in. x 4 in. rough. Spacing is usually 2 ft. to 2 ft. 6 in. center to center. The lumber list for each member should include these miscellaneous items:

Number of feet of batten material required; number of feet of ledger; number of feet of key lumber, and skewback footage. This helps to insure that every item has been given attention.

Exterior beams present an additional problem in bracing, as there is no panel and spreader construction on the building line side to keep the form from opening up wider at the top than it is at the bottom. Two methods are generally used to keep the outside of the beam in line. The first is to put a large number of shores under the beam and put spur braces at an angle of 45° between the "T" head on the shore and the side of the beam. While this is the method most commonly used it has several disadvantages. It requires an unnecessarily large number of shores, for one thing, and it also requires that the head of the shore be two or three times as long as would otherwise be necessary. There is the labor of cutting and nailing in place a large number of the small spur braces, and the final disadvantage that the form will often spring anyway, and there is then no practicable method of getting it back into line. This has caused some contractors to adopt the method shown in Fig. 8. A 2 in. x 8 in. or 2 in. x 10 in. plank, depending on the span between columns, is spiked flat to the top yoke of the columns, and wedges are then driven between the plank and the beamside as often as may be necessary to hold the beamside in line. Then, if the form does show signs of working out of line because of spring in the plank, it is a simple matter to drive down such wedges as may be necessary to correct the trouble, while the pouring is going on. By this method no more shores are required than for an interior girder, and the "T" head need be only long enough to give the girder a bearing. This makes the shores much easier to handle. As cutting is rarely required scaffold plank can be used for this bracing to good advantage without extra expense for special material.

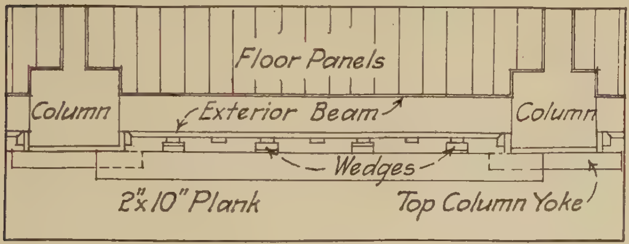


Fig. 8—Method of Bracing Exterior Beams to Avoid Bulging

As shown in Fig. 3 the beam forms have a 1¼ x 4 or 2 x 4 ledger spiked to the side cleats. This ledger carries the spreaders on which the floor panel is made up. Fig. 9 gives a cross section through two beams, which shows the construction. The spreaders are 3 in. x 4 in. rough, sized at the ends to 3¾ in. or 3½ in. This is best done by making a saw cut about 6 in. long at the required length, but before they have been made up required length, but before they have been made up into into panels. This is just the same as sizing the underside of a floor beam in ordinary brick or frame construction to keep the floor level.

Thet length of the spreader will be the measurement between the beam forms. As the clear opening between the beams in the drawing is given at 6 ft., the back to back distance between the beam sides would be 5 ft. 9½ in., which would then be the length of the spreaders. The ends of the spreaders should be slightly beveled as shown.

The floor panels, too, will have to be patched out each roofers. The width of the panel should be 1 in. less than the clear span between beams, this allowing ½ in. play all around. The edges of the floor panels should be chamfered or beveled as shown in Figs. 9 and 10.

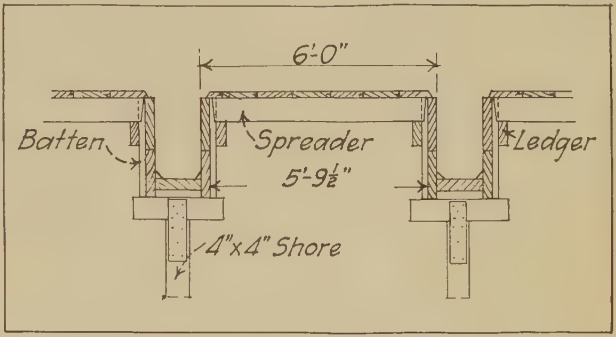


Fig. 9—Section Through Floor Forms to Show Relation Between Beam Forms and Floor Panels

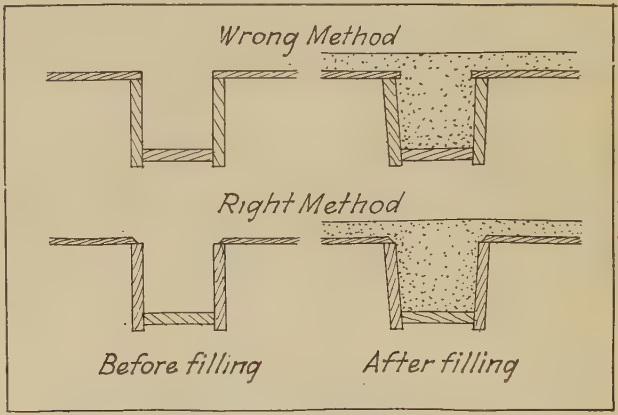


Fig. 10—Showing How Floor Forms Will Bind in Place if Not Properly Made (Exaggerated)

Beam and girder forms will sometimes spread at the top when being filled. If this occurs, and the panel is not made with the ½ in. clearance recommended, and the edges beveled, it will bind as shown in Fig. 10 and be damaged in stripping.

The floor panels, too, will have to be patched out each time the columns reduce in diameter. This may be done by simply adding in a little filler piece each time, which is rarely satisfactory in appearance, or the following method may be used. As shown in Fig. 11, the corners of the panels adjacent to the column are made with the boards running at an angle of 45°. When the column size reduces, the short boards in this corner section are taken off and new boards substituted. When a circular column is used the same method is followed, and after the necessary new boards have been put in the panel a circle of the required radius is scribed on the panels and the cut made with a compass saw. This method of building the floor panels and patching them out always leaves a clean, neat corner at the column. When sheet metal column forms are used the metal form is usually run up first to the under side of the girders, and the space between the girders and beams filled out with four pieces of metal of the proper size, curved to the same radius as the column. These pieces usually lap the column form and are bolted to it.

Occasionally a special case will arise in long span beam and girder construction in which it would be dangerous to remove all the shores from under a beam and leave it entirely unsupported during the operation of stripping. Two methods are shown in Figs. 12 and 13, which have been very successful under these conditions.

The method shown in Fig. 12 is suitable for beams somewhat in excess of the usual spans, say 30 or 35 ft. For longer spans the method shown in Fig. 13 should be used. For the method shown in Fig. 12 the beam form is made up practically unchanged, except for the square removable section of the beam bottom located in the center of the span. This section should be the full width of the beam bottom, with the ends beveled as shown in the drawing, and lightly nailed in place when the form is set up. A "permanent" shore is placed under it. By nailing 2 x 6 cross pieces to the 6 x 6, as shown, it can be made to carry the form during the pouring operation. When ready to strip, all the 4 x 4 shores are taken down, the 2 x 6 cross pieces removed from the permanent shore, and the beam lowered to the ground. After it has reached the ground the beam can be skewed around at an angle to the axis of the beam, to permit reposting with the 4 x 4's. When the reshores are all in place the 6 x 6 may be taken down, and the beam form carried away.

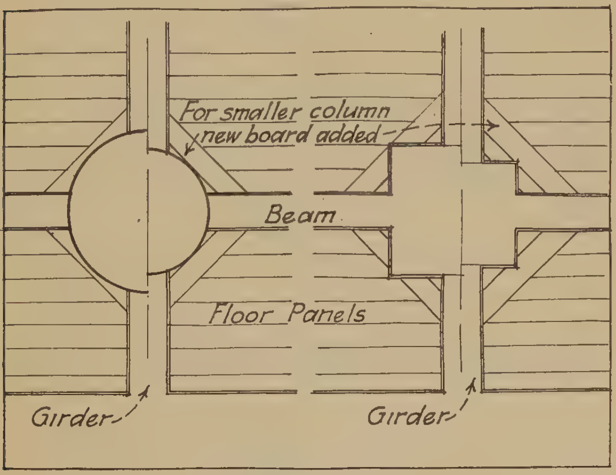
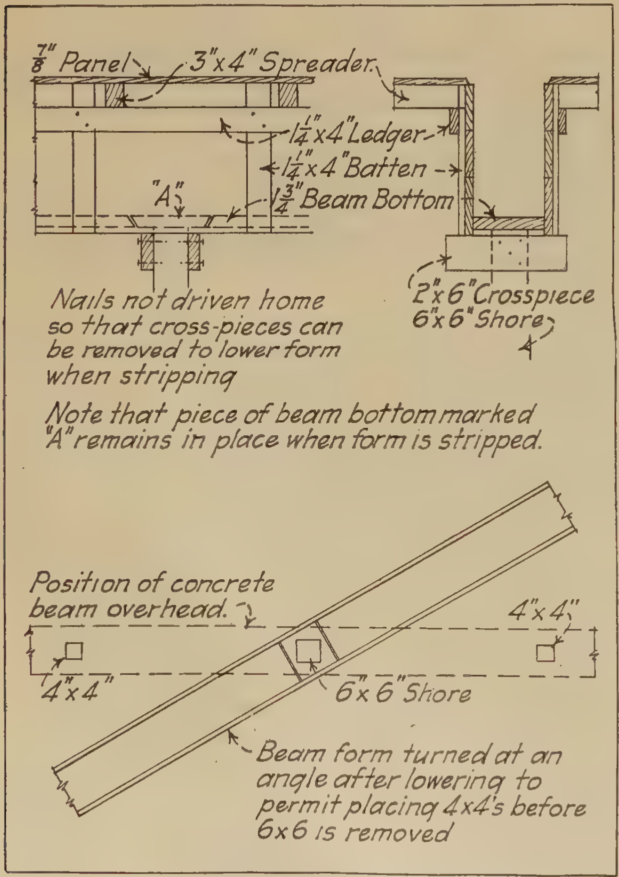


FIG. 11—METHOD OF PATCHING OUT FLOOR PANELS WHEN COLUMNS REDUCE IN SIZE



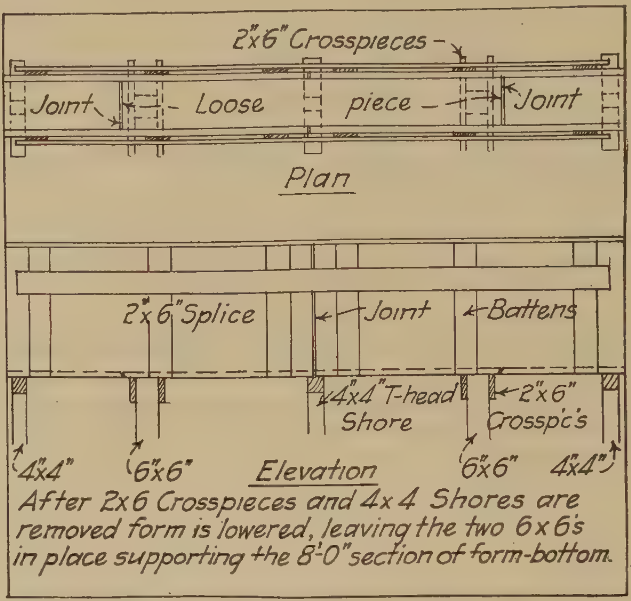
Nails not driven home so that cross-pieces can be removed to lower form when stripping

Note that piece of beam bottom marked "A" remains in place when form is stripped.

Beam form turned at an angle after lowering to permit placing 4x4's before 6x6 is removed

FIG. 12—METHOD OF STRIPPING AND RE-POSTING LONG-SPAN BEAMS SO THAT BEAM IS ALWAYS SUPPORTED

The second method is suitable for spans longer than those mentioned above, and should be used wherever it is thought necessary or advisable to leave one or more shores permanently in place under the beam. The beam form is made in halves, the bottom piece in each half being 4 ft. shorter at the joint end than the sides. The two parts are spliced together on the floor and an 8 ft. section of bottom lightly nailed in place. A 6 x 6 permanent shore is then placed near each end of the 8 ft. removable bottom section, in addition to the regular 4 x 4's. To strip, the 4 x 4 shores are taken down and the splice pieces taken off, allowing the form to be lowered in two parts, the 8 ft. bottom section remaining in place to avoid the slight deflection that might occur by allowing the green beam to go unsupported for even a short time.



After 2x6 Crosspieces and 4x4 Shores are removed form is lowered, leaving the two 6x6s in place supporting the 8'-0" section of form-bottom.

FIG. 13—METHOD OF BUILDING AND STRIPPING LONG SPAN BEAMS TO MAKE PROVISION FOR PERMANENT SHORES

Any kind of a lumber list that gives all the information needed by the superintendent, purchasing agent, and carpenter foreman is a good one, but it is very rarely that a man makes up such a list of his own accord. Very often the man who makes up the lumber list from the drawings is not the man who builds the job; very often he is not even within reach when information is wanted. The result is that the superintendent and carpenter foreman have to guess what half the items on the list were intended for. One man will order 1 x 4 stuff for battens and 1¼ x 4 for ledgers; another will use 1¼ x 4 for battens and possibly the same material or 2 x 4's for ledgers. If the lumber list is not self-explanatory, more of one size lumber will be ordered before the job is over and a lot of other material will be left over at the end of the work.

The simplest method is to go up through the plans, starting with the footings. Tackle next columns, column bracing, yokes, etc. Then beams and girders, and lastly floor panels. After these have been disposed of, special items like pent-houses, stairs, ornamentation, etc., may be picked up. Take the plans systematically, item by item, and for each new kind of construction, such as a footing, pedestal, column, beam, girder, etc., make a sketch at the top of the page to show the arrangement of parts, spacing of yokes, battens, spreaders, etc., and any other information that may be necessary to enable the "next man" to tell how *you* intended to build the forms. Then, if he doesn't want to follow your method, he will at least know where his method differs from yours and how much extra material he will have to order to build the forms his own way. Every man has his own way of allowing for waste and cutting, but if the foreman knows just where each stick of lumber is to go, there need be very little extra material ordered at the start. And every one who has been on a concrete job knows that whether you have worlds of extra material at the start, or none at all, it will be necessary to order just as much during the course of the work. Moral: Make your list so that you need order just what will actually be needed to get the full set of forms built; if you guess and add extra material here and there for safety, you will probably never know where it went, and you'll have to buy more just the same.

What Back-Plastered Stucco Houses Cost

The Ludolf M. Hansen Co., one of the largest construction firms in Wisconsin, has experimented extensively with back plastered stucco construction for small industrial buildings and residences.

Ludolf M. Hansen, head of the company, has been engaged in construction work in Wisconsin for more than 25 years, using all types of materials and has had an excellent opportunity to compare results obtained.

He states that his engineering staff has found that there is a distinct advantage in back plastered stucco over the old type of wooden clapboard construction, both in cost of construction and in results obtained in a climate where changing temperature demands unusual weather resisting qualities.

The comparitive list furnished by Mr. Hansen's engineers will show the difference obtained in actual construction of the two types of houses. These costs are as follows:

Back Plastered Stucco	
Six board feet of lumber per sq. yd., at $35.00	$0.21
Labor on above, with nails	.21
Metal lath, 24 gauge, Armco Iron, Herringbone	.39
Labor on above	.11
Scaffolding, nails, etc.	.10
Back plaster stucco	1.15
Total	$2.17
Contractor's profit and overhead	.43
Total per sq. yd.	$2.60

Clapboard Wood	
Studs—6 board feet, at $35.00	$0.21
Labor on above	.21
Sheathing—12 board feet, at $35.00	.42
Labor on above	.36
Building paper	.10
Clapboards—12 board feet, at $35.00	.66
Labor, at $35.00	.42
Painting—two coats	.75
Scaffolding, etc.	.10
Total	$3.23
Contractor's profit and overhead	.64
Total per sq. yd.	$3.87

The above table shows that the cost of construction with back plastered stucco is $1.27 cheaper per square yard than the clapboard building. It is also pointed out by the Hansen organization that this material cost is but a single item that must be considered, and that there are three others of almost equal importance to the owner of any home.

First is appearance. A stucco home always presents a better appearance. It lends itself happily to natural surroundings, and is adaptable to numerous arrangements and designs not fully brought out in any other type of construction.

Second, stucco finish is more durable, particularly when proper metal lathing and sufficient back plastering is used. The solid wall is so close that air currents and moisture are reduced to a minimum, and the wall when so constructed is rigid and tight.

Third, maintenance is cut in that stucco requires no paint. Its appearance is always the same, and it is safe to say that the percentage of cost in keeping up a stucco finished residence is considerably less than that

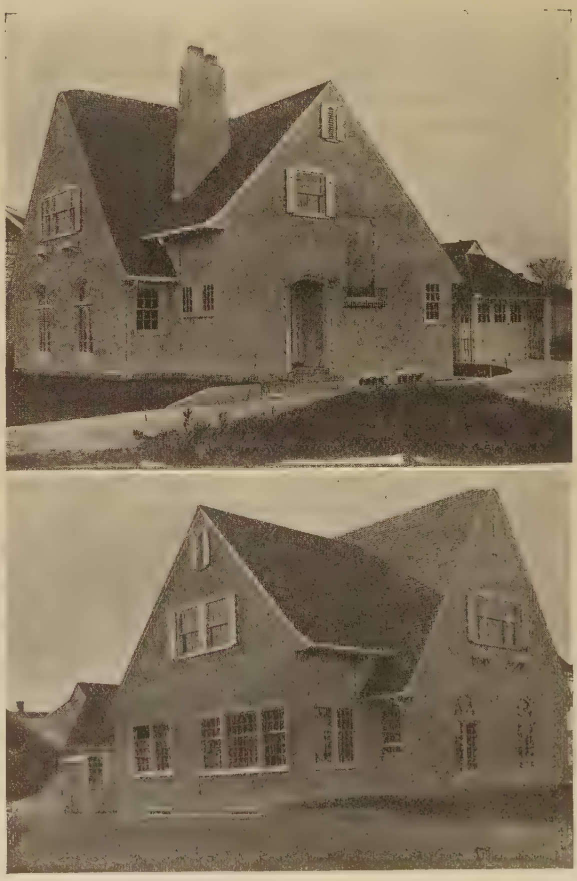


Fig. 1—House of E. Meckelberg, Two Rivers, Wis.—Back-plastered Stucco—Designed and Built by Ludolf M. Hansen Co., Green Bay, Wis.

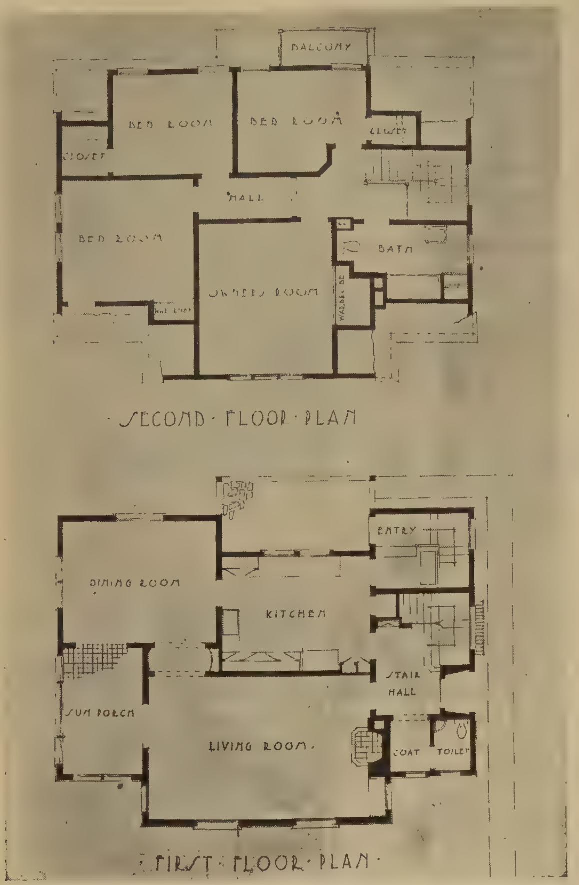


FIG. 2—PLAN OF MECKELBERG RESIDENCE

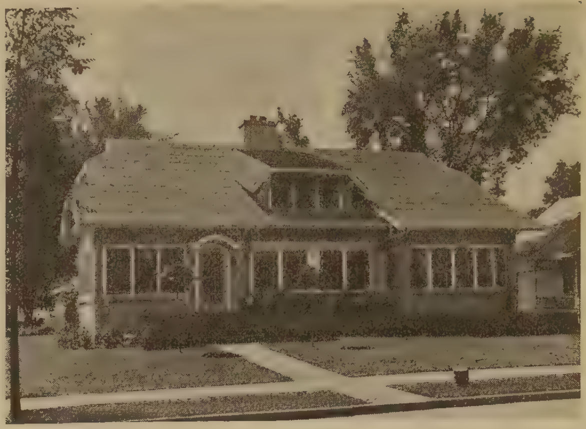


FIG. 3—HOUSE OF LUDOLF M. HANSEN, DESIGNED AND BUILT BY LUDOLF M. HANSEN CO., GREEN BAY, WIS.

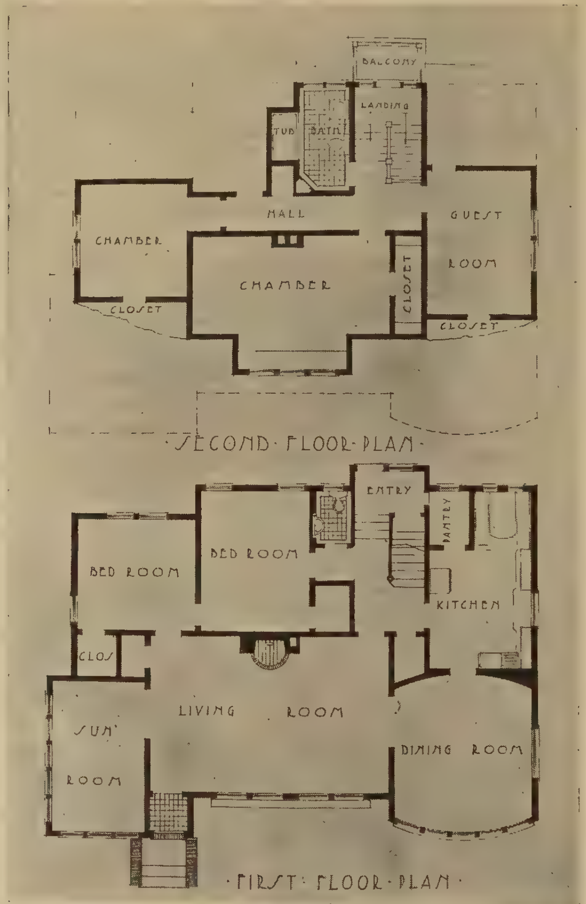


FIG. 4—PLAN OF HANSEN HOUSE

of a wooden house.

The Hansen company's conclusions are not mere guess work. They have been arrived at following an experience with wood construction that dated back before stucco was in general use. The company is not engaged in the construction of residences alone—in fact, during the last several years industrial, school house and factory construction has formed the bulk of its work.

The company has, however, been interested in several large industrial housing programs, and its engineers have gone over every type of construction carefully to select the one best fitted for rapid, economical and durable work.

Following this experience, Mr. Hansen has just had his company build him a residence of back plastered stucco. Not only is the home one of the finest in Green Bay, but it is looked upon as an economically constructed and thoroughly good piece of construction.

When interviewed Mr. Hansen said that during the war and immediately following it, contractors and builders were required to work out some almost impossible combinations, because of a scarcity of men and materials. Short cuts in construction were demanded and materials were selected that could be delivered in a hurry and put up with an equal amount of dispatch.

"We have found," said Mr. Hansen, "that some of the short cuts brought out by this crisis are not fully applicable to the present situation, when both labor and materials are plentiful, and prices considerably changed. On the other hand, we have found that most of the lessons learned during the period can be retained and can be used to good advantage at any and all times.

"My opinion is that back plastered stucco construction received an impetus during the war period that is going to remain with it permanently. My opinion of its durability, economy and adaptability has not changed since we first used this type of construction. I think that it will be used more extensively in the future.

"Our construction program of 1921 called for over a million of dollars' worth of large projects. Such housing as we built in 1921 were of the back plastered stucco type, and I must say that we are very well pleased with results."

The Ludolf M. Hanson Co. is at present engaged in the construction of two large highschools, a large cold storage plant, a theatre, numerous smaller commercial building projects, and is preparing for the laying of oot less than half a million dollars' worth of concrete roadway this year.

Concrete in Front Line Work, 1914-1917

By Edwin C. Eckel[1]

> Major Eckel's articles, "The Cement Supply of American Expeditionary Forces," were published in the Mill Section of the Cement Mill Edition of CONCRETE in November, 1921, to February, 1922, issues, inclusive. A final article on "Concrete in Front Line Work, 1914-1917," from Major Eckel's notes overseas, is in two parts—the first appearing in these pages in April. This is the concluding installment.—EDITOR.

III.—THE FORTS AT VERDUN, 1916

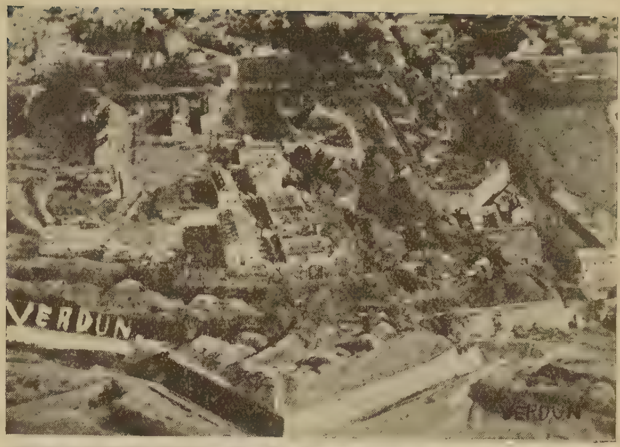
Into practice, Allied and enemy, which had not been as yet standardized, there was now to be interjected a new element. This was afforded by the tremendous, large-scale test of concrete resistance which was offered by the attacks on the Verdun forts during 1916. Curiously enough, the results were to be interpreted very differently by different observers, so that after 1916 there is a marked difference between the lines followed by French engineers on the one hand and by British and German engineers on the other.

The Verdun battle was so serious that it involved a more than normal amount of evasion and mis-statement —on both sides. The Germans, during their attack and after its substantial failure, described Verdun as representing the perfection of modern fortification. The French, after the fall of some of the forts, spoke of the fortress as if it had been a very ancient and partly dismantled group of structures. As a matter of fact, both sides were telling the truth in part, and neither was telling all of it.

The Verdun works in 1914 were, as they had been for some 40 years, one of the four main-line fortresses of the French frontier. There was the usual ancient *enciente* dating from Vauban, which, of course, had no current military value. But, dating from 1874 and modified at later dates, there was a ring of detached forts, forming a circle some 30 miles in circumference around the town.

Most of these forts, as has been said, dated originally from the period 1874-1876, before high explosives had appeared, and were of the familiar design of that period. High relief, the use of brick and stone masonry, vertical or steeply sloping faces, light cover for the magazines and quarters, guns mounted in the open, and lack of specific machine-gun positions, were among their more characteristic features. But after 1888, and particularly after the firing tests conducted at Verdun itself in 1895-1897, and at Bourges in 1901, every fort in the ring had been carefully remodeled.

Aside from the reduction of parapets and other changes which do not concern us at the moment, the chief changes lay in the free use of concrete, to replace stone and brick masonry, to strengthen pre-existing masonry, or to create entirely new structures. The concrete specified for these uses varied according to position. For all shelters, turrets, arches and ceilings it was always portland cement concrete. Though stress was laid, in writing and teaching, upon the importance of reinforcing, there was as a matter of actual fact, but little reinforced concrete used for these purposes. The aggregate was usually gravel, crushed stone being exceptional. The French construction and repair work on permanent forts before the war was done with mixtures which were at the richest about 1 cement, 1½ to 2¼ sand, and 4½ to 6 stone or gravel. This implies at the best a concrete rich enough in cement, but rather overloaded with stone. At the poorest, for less important uses in the forts, the mixture fell far below this, as low, indeed, as 1 cement, 4 sand, and 12 stone.



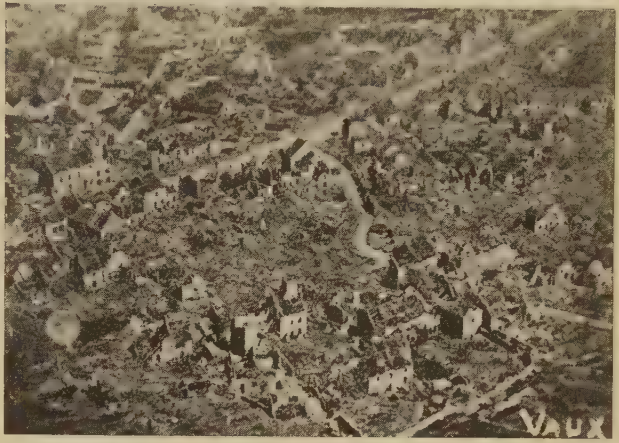


FIG. 6—INTERIOR (SEVENTEENTH CENTURY) FORTIFICATION OF VERDUN—VIEW FROM NORTH

FIG. 7—THE VILLAGE AND FORT OF VAUX, 1916—TAKEN FROM NORTH (OR GERMAN) SIDE—THE FORT SHOWS AS A WHITE OUTLINE IN UPPER LEFT HAND OF ILLUSTRATION

In certain parts of the forts the concrete was made from hydraulic lime instead of portland cement. This was permitted for the revetment of the scarps, for deep foundations, for flooring of shelters. It is economical to use hydraulic lime for such purposes, for it attains high strength in time, so that no one could criticise this particular practice of the French army engineers so far as the material itself is concerned. But from another angle the results are open to question; in using two materials there is always danger of a defective joint where they meet. And at Fort Vaux it seemed to me that part of the damage done in the main casemate was due to inherent weakness at the footings of the arches, arising from this use of two different concretes.

The German attacks upon the outer ring of Verdun forts during 1916 have been discussed in great detail, so that here it is necessary merely to point out the facts which are of direct interest in the present connection. These are: That the artillery preparation was heavy; that certain forts—as Vaux—had independent and long-continued treatment from the German guns; that at the maximum point of German advance, only two forts of the outer ring had been lost by the French; and that at least one of these two forts was still habitable at the finish. Of course, I am using the word habitable in a very special sense; Fort Vaux in June, 1916, was not exactly a desirable residence, but a garrison was living and fighting there, and the magazines were still intact. Its surrender, in spite of a gallant defense, was forced by circumstances which might have happened anywhere: someone in high authority had taken away its 3-in. guns from their turrets, and had forgotten to replace them when the German attack threatened; someone else, in lesser authority, had forgotten to keep the water supply tanks full. It is upon such little errors that success or failure in war may depend.

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[1] Major, Engineers, U. S. R.

[2] *Engineering News-Record*, Oct. 6, 1921.

The closely spaced shell craters in the Douamont-Vaux area are of course the most striking features of the landscape, and I suppose these will be left unfilled for the benefit of tourists. But the effects of the shell-fire on the forts themselves were the most important features, and these have already been to a large extent effaced or concealed.

In the shelling of these fortifications the Germans used calibres ranging from 11-in. up to 16½-in., and the number of hits during the long series of bombardments was of course tremendous. It is estimated, for example, that one of the forts was struck by over 5,000 heavy shells during the 1916 attacks, and that over 300 of these were of the largest calibre, the German 420 mm. howitzer, or 16½-in. As a test of concrete resistance nothing more complete could have been suggested. The masses of concrete that were struck by these projectiles ranged in thickness from a half-metre revetment up to a 2½-metre "carapace" over old masonry. The character of this concrete has been already described above, and must be kept in mind in considering the effects.

These effects are less remarkable for their extent than for their character. Of course, the thinner plates of concrete are broken through, wherever they were exposed to direct hits. The heavier and better covered masses are not, in general, destroyed; though even in the deeper casemates there are badly cracked arches and loose fragments fallen from the roofs. But clean breaks are rather the exception than the rule; the concrete, where it had failed, seemed to me to have failed by continued shock. The pebbles of gravel are *shaken* loose from the enclosing cement-sand matrix. As we know, the concrete was not reinforced in most of this work, and it was a very lean mixture for such work. To my mind those two facts account for the greater part of the failures of concrete masses at the Verdun forts. A better concrete, with at least surface reinforcing, would have shown relatively little damage even under this severe test. This is of course merely an individual opinion, but it happens to coincide with the judgments of some German engineer officers who saw Vaux and Douamont in 1916 and of British engineers who visited the forts later.

On the other hand, the official French judgment is almost diametrically opposed to that just stated. It does not consider the possibility of using a better mixture, and tends in the direction of using plain concrete in thicker masses. Unreinforced concrete from 2 to 2½ metres thick, covered by 1 to 1½ metres of sand, and this in turn by a bursting course—this combination is suggested as being capable of withstanding even a renewal of the Verdun test.

Out of this difference in judgment came a difference in later practice. The French, demanding great thicknesses of plain concrete, decided that concrete was therefore not applicable for temporary fortifications. The Germans went in the direction of richer mixtures and reinforcing; and therefore were able to apply concrete very extensively in the field.

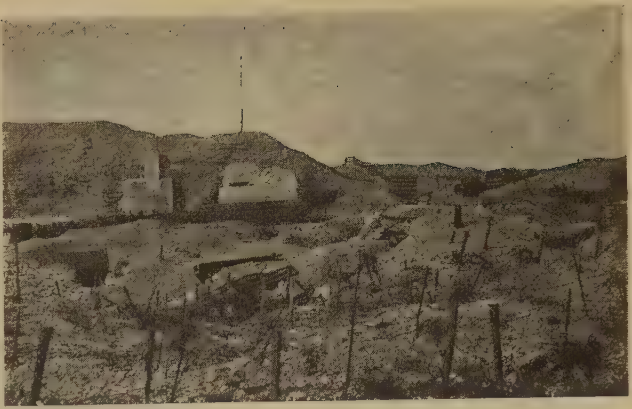


Fig. 8—Fort of Vaux in 1918—Taken from Rear or French Side

IV.—The Hindenburg Lines, 1916-1917

The fact that the Germans attacked Verdun twice during 1916 should not make us overlook the fact that throughout that whole year and the first half of 1917 they were generally accepting a passive defensive attitude so far as the Western Front was concerned. So long as the Russians were in the field no other attitude was indeed possible in the west, for the Allies still had a very great preponderance in men available on that front.

The natural consequences of these conditions was that the German lines were strengthened in every possible material way, so as to make up for the deficiencies in man power. It was during this long period that the so-called "Hindenburg Lines" attained their maximum of strength, and in putting these defenses into condition to resist the anticipated Allied attacks, concrete was used with greater freedom than at any other time or in any other region. After midsummer of 1917 the German plans tended toward attack rather than defense, for the spread of the Russian revolution removed further fears from that quarter, while the Italians had plainly shot their bolt. But during the year of waiting great progress had been made in the military use of concrete.

During that period attention must be concentrated on German practice, for various reasons. The British were preparing for attack, not for defense, and did little in the way of heavy constructions. In some parts of the front they did not do enough for safety, as some regrettable incidents later showed. The French, after Verdun, drifted farther and farther away from massive construction in any line; under the urge of absolute necessity for economizing on coal, cement and steel, their designs developed along lines which would probably not meet with general acceptance under normal conditions.

For Germany the conditions as to structural materials were curiously favorable. Cut off from her normal export trade, there was therefore an actual excess of coal available, and in consequence both cement and steel could be made in quantity and used freely. So wherever concrete and steel could be gotten into a trench line we find them used, and used in quantities which approach those of permanent fortification.

The official German view of the necessities of the case, after two years of experience, is best indicated by the following paragraphs from the November, 1916 issue of instructions:

"Splinter-proof shelters have shown themselves worse than useless, for they not only give no real protection, but their debris obstructs the trenches.

(Continued on Page 222)

Diversified Manufacture for Products Plants

It's a Good Idea Not to Have All Your Eggs in One Basket

BY MAC HANSON

> This article was written by a concrete products manufacturer for concrete products manufacturers. This is the second of several articles being prepared by this same manufacturer, considering the business end of products manufacturing. He prefers to be known as Mac Hanson—which is not his name.—EDITOR.

Did 1921 give you a solar-plexus blow in your business? Or, worse yet, a knock-out blow? Almost every manufacturing business suffered from reduction of sales, many suffered losses, and not a few failed. But this is no reason for their throwing up their hands and quitting. The thing to do is to study the stiuation as we now find it and start doing business again. That's the answer. Start doing business again, but do a diversified manufacturing.

An editor, who published a paper in a rural community that did grain farming only, i. e., corn and oats, commented on the farm situation somewhat after this fashion. "Our farmers are grain men only. No dairying is done. No cattle feeding and no hog raising as a commercial proposition. Every farmer raises more or less hogs, but this business is a side line to grain farming. The folly of a single farming policy is now fully realized. The wise man will plan to get his products as near ready for human consumption as possible. Raise hogs on a businesslike basis as a commercial proposition. Study into and adopt a businesslike system in poultry production. Start a dairy. Keep records and cull out the loafers. These three things—hogs, poultry, and dairy products—have been at a high price and produced a profit during all these months that corn and oats have showed enormous loss. Our farmers must diversify their operations to win."

This is good advice to all those in the concrete products game. Our concrete products manufacturers must diversify their operations to win. A manufacturer in the middle west made concrete farm drain tile and concrete silo staves, only. Thus his only customers were farmers. He had practically no trade in 1921. "I should have been wise enough to have foreseen such a situation, but I did not. If I had followed a more diversified manufacture I might still have done business. Concrete road culverts are quite similar in manufacture to large drain tile. The outlet for these products is entirely outside the farmers and was fairly good in 1921. Burial vaults are sold to all classes of trades people. Building trim and porch trim are sold to the wealthier trade—business firms and residence owners. Railroads are large purchasers of concrete fence posts. None of these lines requires an outlay in forms and machinery equal to what I have in my present business, and if I had diversified my manufacture so as to have included all of them, or even two or three of them, I would probably not have been in the tight situation in which I now find my self. For if the farmers did not buy tile or silos, the State Highway Commission would probably have required quite a few culverts. Or I could have promoted the sale of the trim for those new business buildings there, or sold fence posts to the railroads. Burial vaults sell at all times—hard or easy. Diversified manufacture is the solution of the products manufacturers' difficulties today, if he can get hold of more money to invest."

A member of the National Concrete Stave Silo Association expressed the same view last fall. "We feel that it is imperative for us to get into general concrete products manufacturing at the earliest possible moment. This, in our opinion, is the real and only system under present conditions. To do this on a fairly large scale, as you know, has meant a great amount of hard work and careful thought to select the best and most modern equipment, which, with proper management, will spell markets, high production, and last, but by no means least, low costs." Diversified manufacture is his solution of the present difficulty.

The Goodyear Tire Company not only makes tubes and casings, but rubber belts, rubber boots and shoes, hot water bottles, and dozens of other articles of rubber. The Quinn Wire & Iron Works, not only makes the tile machines, but does a general business in high grade castings which has become one of its most important lines of manufacturing.

Those concrete products manufacturers who also sell and erect buildings constructed of their units, can diversify their sales outlet, also. Plants originally built to manufacture staves for silo erection only, are now branching out and erecting coal pockets, elevators, sand bins, barns, storage cellars, septic tanks, cisterns, garages, granaries, water storage tanks, etc. Whereas, before, their trade outlet was the farmer only, now they also sell coal dealers, elevator men, building materials retailers, merchants, residence owners, town's people, etc.

Block manufacturers could work out this same idea. By undertaking the building construction itself and by proper use of inside plastering and outside stucco and of reinforcement, a block manufacturer should be able to get contracts and erect a wide variety of structures. He can take on residences, store buildings, factory buildings, and such structures, which the stave manufacturer cannot handle because of the natural limitations of his product.

Enlarging the sales outlet of products you are now manufacturing by broadening the uses to which your products can be put, does not require one cent additional factory expense. It does require more and better advertising, salesmanship, and promotion. Generally it will require another department of your business—the construction department. Often, however, the manufacturer can tie up with some local builder or contractor to do this work. It does especially require a broader vision and intensive intelligent study on the part of the owner or manager, to get himself posted on the principles of construction involved, on the system of field operations necessary, and on the proper promotional efforts. And above all it requires an exact knowledge of costs so that an intelligent selling (or bidding) price can be named and so that the costs of construction can be regulated. Some system of cost accounting must be established in order that the manufacturer may positively know that he is making money and not losing money.

If the other policy is adopted—that of taking on new lines of products in order to diversify operations—then, not only is there required more and better advertising, salesmanship, and promotion, but there is also the question of new investment. In the March number of CONCRETE is an article on this subject entitled "Products Plant Investments, Production, and Profit," which you should read carefully in this connection.

If, after due consideration, you decide to diversify your manufacturing by adding new lines, then the question arises as to what these new lines shall be. Granting that you will have sufficient funds to make the new investment and still have sufficient operating capital, the decision still depends upon several local conditions, chief of which are the possible outlet for sales, and your knowledge of the new business—either already acquired or that you feel you can acquire.

For example, if you have no knowledge whatsoever of building construction nor any training that fits you to acquire such knowledge readily, then you should not take on contracts for residence or factory building unless you can tie up with a contractor who will handle the building construction end. If possible, it is better to take on a new line somewhat allied with, or similar to your present line, so that your knowledge already gained can be directly applied to this new line.

An entirely new line may mean a long promotional effort or gaining experience at great expense—either of which would defeat the purpose you have in mind, namely, to diversify manufacture in order to make a profit, and make that profit now.

A study of the "possible outlet for sales" is a wise and profitable study, especially if made before you invest. If a community is doing considerable road construction and the lay of the land in general is flat, no doubt there will be a good outlet for sale of road culvert pipe. If the lay of the land is very rolling, not so much culvert pipe will be required.

If your community is open to dairying, or to cattle raising, there should be a big demand for silos. If it be a grain raising community silo sales will ordinarily be poor. Rich productive land generally requires a large amount of tile drainage, because it is usually flat and wet, and because it is used for raising crops. Hilly or rolling land generally does not get much tiling, because it has natural surface drainage and because it is used principally for grazing.

If a manufacturer is located near large towns or cities and has good shipping facilities, he can count on a good outlet for coal pockets. But rural coal dealers are not yet ripe for this kind of sales.

It would be foolish to take on a new line, e. g., let us say silo stave manufacturing, when your field was thoroughly covered by another local manufacturer. For, in turn, he might then be forced to take on your line to keep up his volume of business. Or again, suppose a silo stave manufacturer is thinking of adding farm drain tile to his line. If his costs for sand and labor are high and he finds that a clay tile manufacturer is covering the territory with good tile at a cheap price, then the silo stave manufacturer had better stay out of the tile game. If the clay tile man is making a poor product even at a cheap retail price, then the silo stave manufacturer could consider concrete farm drain tile manufacturing and depend largely upon the high quality of his products selling them at a higher price.

These examples illustrate the statement that local conditions which determine the possible sales outlet are a deciding factor in determining what new lines to manufacture.

We have already mentioned the concrete stave and its various uses; the concrete block and its uses; drain tile and culvert pipe and their sales outlets. Concrete fence post manufacture has been developed to the point where it has a good sales outlet for the farm, railroads and highways, and can compete in price with the wood fence post, except in timbered localities. Even timbered localities, knowing the dangers and ravages of forest fires, will buy some concrete fence posts.

Concrete burial vaults are a ready seller with a good margin of profit and do not require a large investment. A very small investment is required for concrete monument work, the profits are large and the sales outlet good because the sales price is much less than marble or granite monuments. These two lines are worth investigation.

Building trim, porch trim, garden furniture, and ornamental concrete products are lines requiring small investment and can be added as a side line in any community, or by proper promotion and greater investment and greater care in making a very high quality product, they can be developed into a big business.

Concrete roof tile should have a ready sale in almost any community where much construction is going on. Roof tile does not require a large investment unless a big quantity production is desired, nor is this line worth while unless a reasonably good output can be maintained. It is best developed by contracting for roofs laid.

Lighting standards, guide posts, highway and right-of-way markers, railroad ties, battery wells, etc., are other lines, but they require a more specialized knowledge, have specialized sales outlet and usually require larger investment and larger promotional effort and greater and more specialized sales effort. The Portland Cement Association has a booklet entitled *Markets for Cement Products* which you should get and study.

No matter what decision you make, don't forget the expensive lesson that 1921 taught you. Go ahead, but go ahead wisely. Let your enthusiasm be tempered with prudence. "Never risk for a palace that which you may need to keep you out of the poor house."

Diversified manufacture means that your business is not specialized. Specialized business is subject to a knock-out blow if hard times happen to hit that particular line of business. It is proper and generally advisable, due to the limitations of personal ability, that your main line be specialized, but have some other lines developed in a field with entirely different sales outlets, upon which you can rely to carry you through when the specialized line is given a solar-plexus blow.

If concrete products manufacturers will put their particular problems up to the Editor of CONCRETE, it will help in accumulating the best and most useful articles for the products field for publication in these pages.

Block Business Is Built Up by Good Jobs

How Fellabaum Does It

When Elias Fellabaum started a block business in Toledo, Ohio, 17 years ago, he had the blocks laid under his supervision. He always insisted, whenever possible, on giving the outside of the foundation a waterproofing coat of cement mortar. This made a waterproof job certain despite poor mason work. This introduction of a well-built product left a favorable and lasting impression of concrete building units and connected the name of Fellabaum with permanence in building. Up to the present time Fellabaum has made enough block to build 5500 foundations besides a few factory buildings of considerable size. In the last five years he has found it essential to maintain a building material yard in conjunction with his block plant in order to market the block. Many prospects are lost to block manufacturers because the builder goes to the building material dealer for his plaster, cement, etc., and then buys brick or clay tile just because it is handier. Two outside salesmen now handle the supplies and the block for this company and effect many block sales which would be impossible under any other plan of operation.

Fig. 1 shows the layout of Plant No. 1, operated by this company. It is equipped with a Besser double block machine, fed by a continuous mixer of the same make. On a floor over the curing rooms, 2 hand multiplex chimney block machines and 3 Walter roof tile machines are operated.

The sand, screenings and cement are received on railroad cars on the siding along the back of the building. The cement is unloaded by laborers who also do yard work. The sand and screenings are dumped into an elevator pit and lifted to overhead storage bins. A conveyor which is built so as to serve both bins brings both the sand and screenings to bins directly over the mixer. They are automatically proportioned and fed to the mixer by gravity. The cement is carried by hand up a flight of stairs to the mixer level.

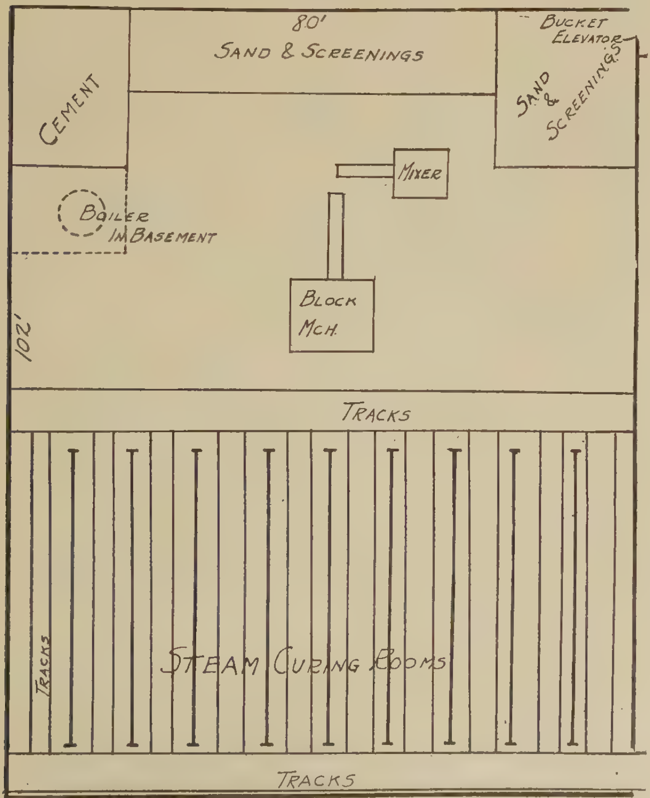


Fig. 1—Plant No. 1. Erie Cement Products & Supply Co., Toledo, Ohio

The blocks are made of a 1:5 mix of cement and aggregate composed of one-half sharp sand and one-half stone, from dust to ⅜ in. screen. The blocks are faced with a 1:2 mix of cement and sand.

The block are placed by the off-bearer on rack-cars that hold 48 block each and conveyed to the curing room, with a capacity of 4500 block, where they are cured by low pressure steam for 24 hours. The boiler which generates the steam is set to blow off at 14 pounds pressure. This insures a low pressure steam which is admitted directly to the curing room without the water barrel, or trough, which is essential with high-pressure steam. This method has been found to keep the blocks sufficiently wet and is more economical than high pressure steam.

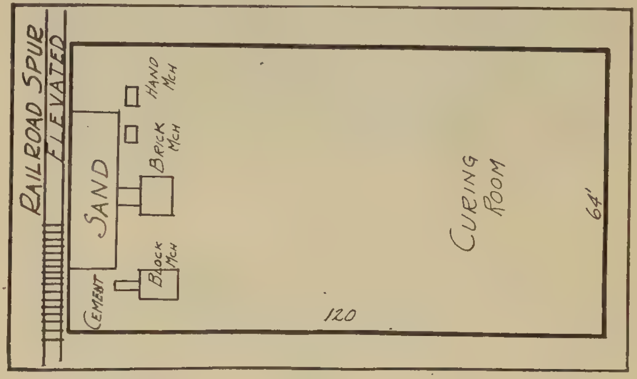


Fig. 2—Plant No. 2. Erie Cement Products & Supply Co., Toledo, Ohio

The plant has a capacity of 3000, 8 in. by 8 in. by 16 in. block per day and can be operated at this capacity by 7 men, one machine operator, one man on the mixer, 2 off-bearers, one man to feed cement to mixer and push off the loaded cars and two men to take out the block and pile them in the yard. In addition to this there are three men operating the chimney block and roof tile machines.

The layout of Plant No. 2 is shown in Fig. 2. It is equipped with Besser brick and block machines and two multiplex chimney block hand machines. The brick and block machines are run in connection with the new type Besser batch mixers. The operators have attained an output of 2500 block and 40,000 brick per day with this equipment.

The aggregate and cement are received on the railway spur along the back of the plant. This siding is elevated and the sand and stone are merely dumped on the ground underneath it. The cement is unloaded and brought inside the building.

A conveyor brings the sand and aggregate into the building to the mixers where they are proportioned and mixed. Cement is handled by hand. The same proportions are used in this plant as in the other.

As the block and brick are taken off the machines they are placed on specially constructed racks and transported by lift trucks to the curing space at the other end of the building where they are cured naturally, being kept wet for 24 hours.

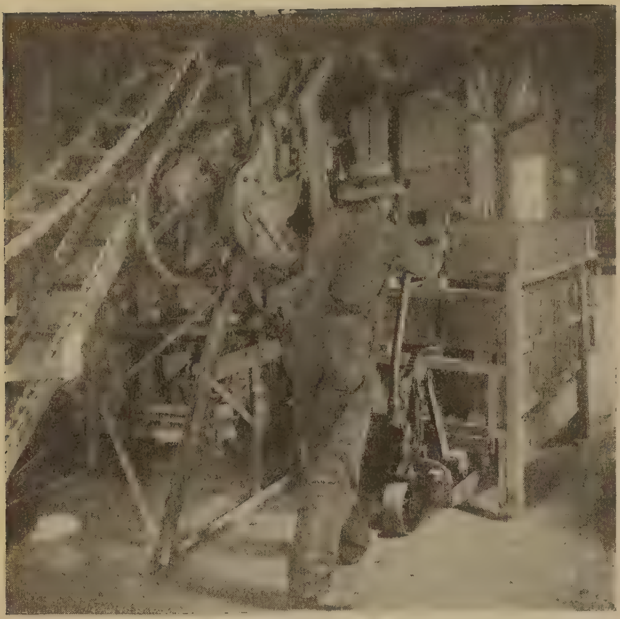


Fig. 3—Block as Handled from Machine In Plant No. 2 On Lewis Shepherd Lift Trucks

This plant is operated at full capacity by 15 men; three men handle the output of the block machine, seven men operate the brick machine, two men run the hand chimney block machines and three men carry away the block and brick to the curing space and remove them from there to storage in the yard.

The layout of the plant of the Peerless Block and Supply Co., Charlestown, West Va., also owned and operated by Mr. Fellabaum, correspondnds closely with that of Plant No. 2. The system and method of operation in use here is identical with that of the Toledo plants.

All the buildings used for the various block plants are well built, concrete block structures with concrete floors and plenty of light and head room. Electric power is used on all equipment.

Men are paid by a system which has met with very good results, a piece rate based on the production of the entire force. At the end of the day, one of the workmen who is given a small sum to act as foreman counts up the number of block turned out and each man is paid a piece rate on this number. This system makes the men particular about the work of their mates and very eager to get rid of a shirker. One disadvantage of this system is that sometimes the quality of the block turned out is poor, but if the additional compensation given the foreman depends on keeping a good standard, he will see that the block are well made. Under this system the foreman also does the hiring. Block 30 days old have shown a compressive strength of 2400 pounds to the sq. in.

At a recent builder's show in Toledo, the company did some effective advertising and secured a very good list of prospects by moving one of the Besser block machines to the exhibit and giving a demonstration. Blocks were made of moist sand and were taken by the offbearers and dumped on the conveyor belt in the rear of the machine. One order was secured as a result of this exhibition. Many other people interested in building stopped and gave their names to the persons in charge, expressing a desire to learn more about the use of concrete building units. The results of the show were considered very satisfactory by the company.

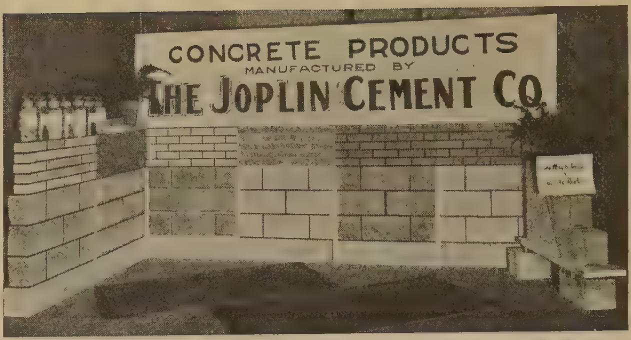


Exhibit of Concrete Building Units at Industrial Exposition, Joplin Cement Co., Joplin, Mo.

Overcome Prejudice With Good Products

In localities where concrete block are objects of considerable prejudice on account of unsatisfactory experience with poor products, the only way to overcome and stamp out this business bugaboo is to educate the public to the excellence of products properly manufactured. One way is by exhibitions.

A well-planned, attractive and interesting exhibit of concrete building units such as shown in the illustration of the Joplin Cement Co.'s display at a recent industrial exposition in Joplin, Mo., goes a long way toward overcoming prejudices and creating a demand for concrete building units.

F. M. Myers, president of the company, has done much to develop the block business in Joplin. At one time the business was held up by the lower insurance rate given to brick buildings than to structures of concrete block. Mr. Myers investigated the matter, collected data and finally succeeded in having the rates adjusted so as to be more favorable to concrete block construction.

The company has always endeavored to turn out blocks of good quality, adopting as its slogan, "When better concrete products are made, the Joplin Cement Co. will make them."

The plant is equipped with a Hobbs block machine with an Anchor tamper attached. Zagelmeyer molds for poured block, two hand machines for specials, brick, caps, sills and lintels complete the equipment. The average daily output of the plant with three men is 400 block and two cars of special products.

The aggregate used consists of specially selected Joplin chats or the waste product from the lead and zinc reducing mills in that locality. This can be had for the hauling. An aggregate screening from 3/8 in. to dust is found most suitable. A washed and screened river sand is used for the facing mix. Product blocks are steam cured for 48 hrs. and then stored in outdoor yards. Local newspaper advertising and direct mail advertising are used extensively in acquainting the public with the value of the concrete block as a building unit. Both means are producing results.

Products manufacturers should read Mac Hanson's article on "Diversified Manufacture for Products Plants" in this issue.

Stave Strength and Quality

Standards Needed to Meet Varied Uses

Extreme variation in strength of staves used for silo, tank and bin construction is noted at the outset of an effort on the part of Committee P4—Concrete Staves, Walter Brassert, Chairman.[1]

The objectives toward which the work of the Committee is directed are:

Item 1. Determination of standard of quality of staves.

Item 2. Formulation of specifications covering methods of manufacture.

The chairman reported finding difficulty in arriving at any suitable basis for standardization. The variety of purposes to which stave construction is being applied involves a very wide range of requirements. This is an illustration of an extreme case of tank construction where the strain imposed upon the staves by the hooping amounts to over 1,300 lbs. per inch of height of stave, while in all ordinary farm silo work, hoop strains are rarely more than 10% or 12% as much. The quality necessary to meet such a condition successfully will, of course, depend also upon the thickness of the stave used.

The minimum requirements as to accuracy of size and shape will differ also with respect to the type of interlock employed. Again, with respect to absorption, resistance to abrasion and other qualities, wide variations in requirements would be imposed by the various purposes for which staves are needed.

It is taken for granted that each manufacturer will make, for reasons of economy and simplicity, a single grade of stave as his individual standard. It will be further agreed that such staves should meet certain minimum requirements. It follows that staves of varying merit may come into competition in some cases on work requiring special strength. The Chairman proposed that the thought of the committee be devoted to question of specifying a limitation of size of any silo vessel in the various sorts of services for which staves may be used which it would be considered permissible to construct with the stave of standard qualities. Where specially severe conditions of superimposed weight, or high hoop strains demand it, a special stave, better than the standard, would be offered.

Mr. Brassert's firm has built several elevated water tanks, in some of which the actual loads carried to the ground by staves run up to 200 lbs. to the square inch. It is felt that, owing to imperfect end bearing of staves and also to the fact that stave walls are thin and impossible to construct precisely vertical throughout, that the stave manufacturers generally should recognize the importance of building, in such special cases, with a unit that represents the very highest obtainable qualities. If this policy is not followed, there may be failures of stave structures that will work to the detriment of all engaged in the business.

Tests of staves to the number of 103 have been made at the Lewis Institute under direction of Professor Abrams and at the factories of Mr. Brassert's firm. It appears impossible to draw any but the most general conclusions from the results. We have proven to our own satisfaction the merit of careful restriction of use of water in the mixture where the wet cast method is employed has been proven; the merit also is proven of sprinkling the staves for a period of a week or more, where either the dry tamp or wet cast system is employed.

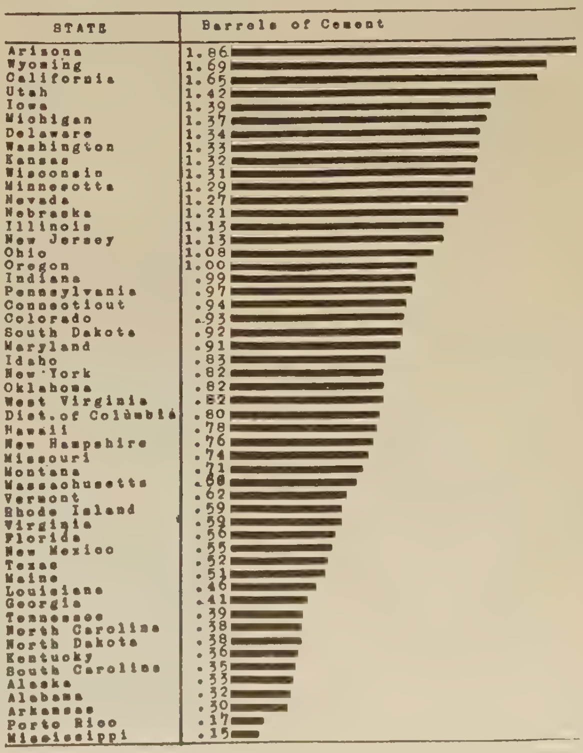
The method of testing, which gives information of the largest general value, is considered to be the transverse break test. In making comparisons of staves tested by this method, the basis for comparison can be only the modulus of rupture; that is, the extreme fibre stresses produced in the stave. For a given condition of loading and length of stave, the resulting modulus of rupture is, of course, dependent upon width and thickness of the stave.

In attempting to draw conclusions from results of tests above referred to, extremely wide variations are noticed ranging from less than 200 lbs. to the square inch to over 1,000 lbs. to the square inch of extreme stress on concrete. It is interesting to note that these extreme figures are both recorded with staves made by wet cast system.

Tentatively, it is considered that a stave, to be satisfactory for general purposes, should carry a minimum of 750 lbs. load concentrated at the center of a 28-in. span; the staves being 10 in. wide and 2½ in. thick. This condition calls for modulus of rupture of 500 lbs. per square inch.

Percapita Consumption of Cement by States

Here is a diagram showing the barrels of cement consumed per capita in 1920 by states by which it appears that Arizona is at the top of the list with 1.86 barrels of cement per person and Mississippi with .15 barrels of cement per person for the year 1920, at the bottom.



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[1] Abstract of Report at convention American Concrete Institute—Proceedings, Vol. 18, 1922.

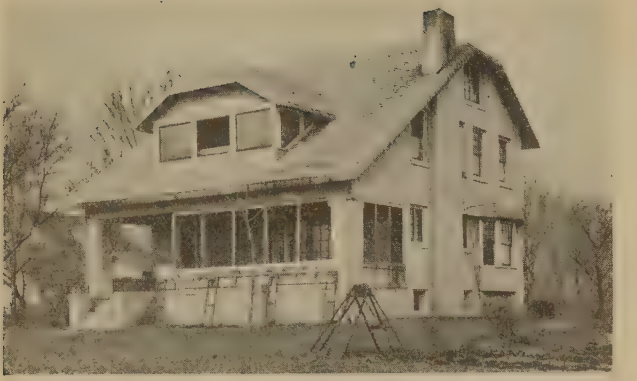


Fig 1—The Roof Was Put On This House In 1915 by the Walton Method—Cement Mortar On Metal Lath. The Illustration Is from a Photograph Made In 1921.

Reinforced Concrete Shingle Roof

Put On Like Stucco

The roof on the Kansas City dwelling illustrated is made of portland cement mortar and metal lath laid directly on board sheathing, resulting in a construction similar to portland cement stucco and metal lath on a wood frame building. It is the Walton method and is being developed commercially by E. H. McFall, Chicago. The house is in the Swope Park district. It was built in 1915 and the photograph used for this illustration was taken in 1921. The roof is in excellent condition and attractive in appearance.

In placing this roof the mortar is laid in 18 in. horizontal courses, or layers, corresponding somewhat to the placing of a wood shingle roof. In starting a new course, a straight-edged board is laid across the lower part of the preceding course to serve as a butt for the new course. A strip of metal lath 18 in. wide is then placed and the mortar is applied with a trowel. The course is made the same thickness as the straight-edged board at the butt, and is then gradually tapered off toward the upper edge. The workman operates from above in order not to damage the freshly placed mortar. Immediately after the mortar is deposited and smoothed off, the course is divided vertically into "shingles" by means of a special tool which cuts the mortar as far as the metal lath. Although this may cause the eventual rusting of the metal lath along the exposed part of the groove, it is anticipated that no damage would result, as the effectiveness of the shingle would not be affected. In fact, if extreme expansion and contraction were to take place it would be preferable to have cracks form in these grooves in order to relieve the stress elsewhere. Cracks in the grooves would not cause leakage, for the reason that the grooves are staggered with respect to those in the preceding course, the same as with wood shingles.

Special features such as gutters, hips and valleys, are made by bending the metal lath to the required shape, then applying and molding the plaster. Sheet metal work is therefore eliminated and this alone means a great saving in maintenance, as owners of dwellings well know. The accompanying diagram illustrates the formation of a gutter and the sill of a dormer window.

In starting the roof, a second layer of mortar and metal lath is placed directly on the starter course, to produce broken joints in the first course. The figues in circles in the diagram point out the various steps in the work.

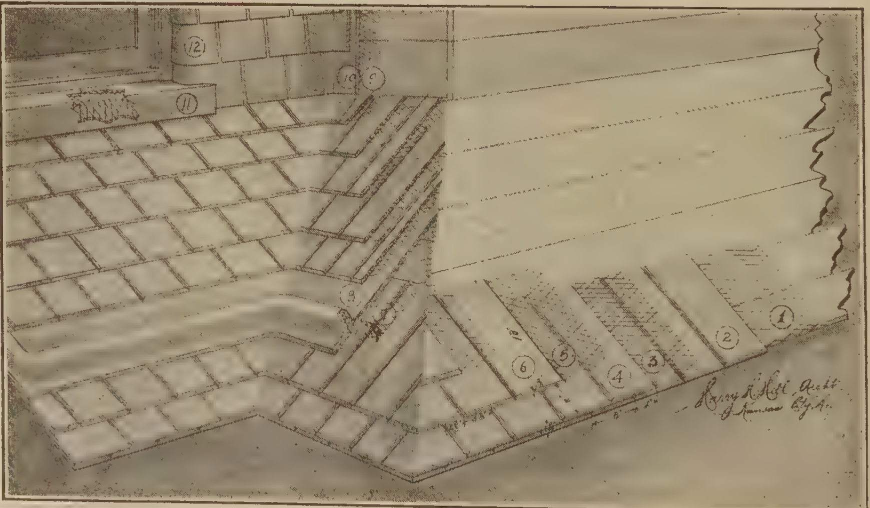
Incidentally, the exterior walls of the house illustrated are double reinforced concrete, built with a double-wall machine. The interior construction, however, is of wood.

The roof on the building illustrated is very attractive, and its clean-cut appearance indicates that it was placed by a highly skilled workman. The roof, in fact, was built by the man who originated the idea and took out patents covering it. A skilled workman in a small or medium sized city might be able to build up a business of his own by taking contracts for such roofs and actually doing the work himself or employing only thoroughly reliable workmen. This seems to be the logical possibility for development.

See elsewhere in this issue the article by Mr. Curtis on roofs for concrete houses—one of his series of articles on concrete building units.

Fig. 2—Diagram Showing Various Steps In Making Roof

Nos. 1 and 2 show the starter course. Nos. 3 and 4 show the second starter course previously mentioned. Nos. 5 and 6 indicate the second shingle course. Nos. 7 and 8 show the method of forming a reinforced cement mortar gutter on a pitched roof. Nos. 9 and 10 illustrate a vertical surface as on a dormer. Nos. 11 and 12 show the formation of a window sill and a curved window reveal.



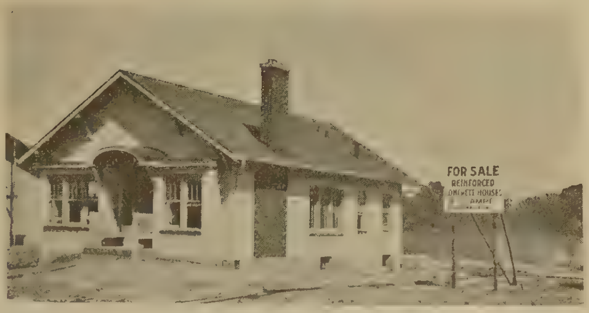


Fig. 1—One of F. O. Campe's Houses Built at Morton Grove, Ill., by the Fellgren System

Chicago Houses by Fellgren System

Occasionally, individual interest is sufficiently awakened by the prevailing housing needs to prompt an investigation of what can be done not only to relieve the housing shortage, but to provide a more permanent, fire resistive house than commonly constructed. F. O. Campe of Chicago, is one of these individuals. A tract of land at Morton Grove, near Chicago, was available which he decided to improve. A careful study was made of market conditions, materials and types of construction; first considering the usual brick, tile and frame type, and later reinforced concrete. His thought was to build the best possible type of house for a fixed sum based on durability, economy and upkeep expense. Several cities were visited where construction was under way and after due consideration concrete was chosen.

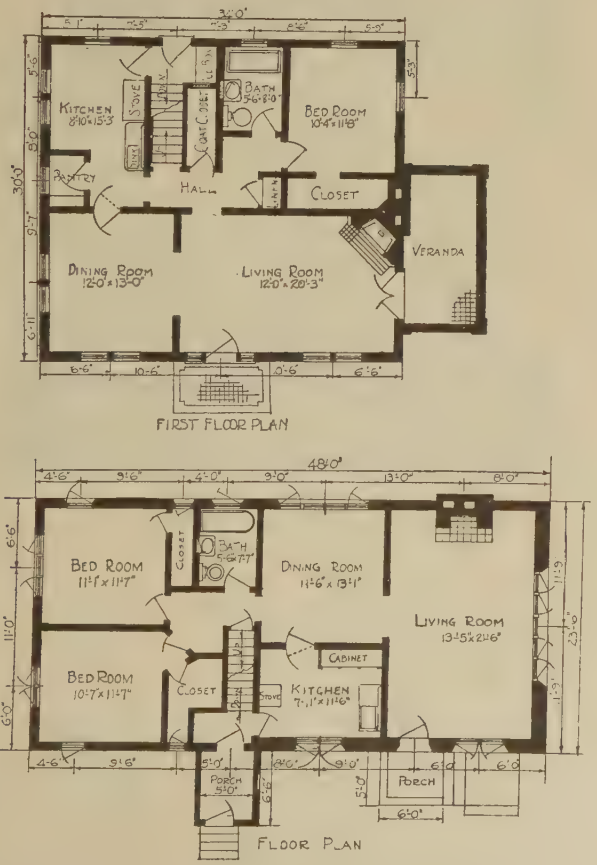


Fig. 2—Plans (Nos. 1141 and 1140) Morton Grove Houses

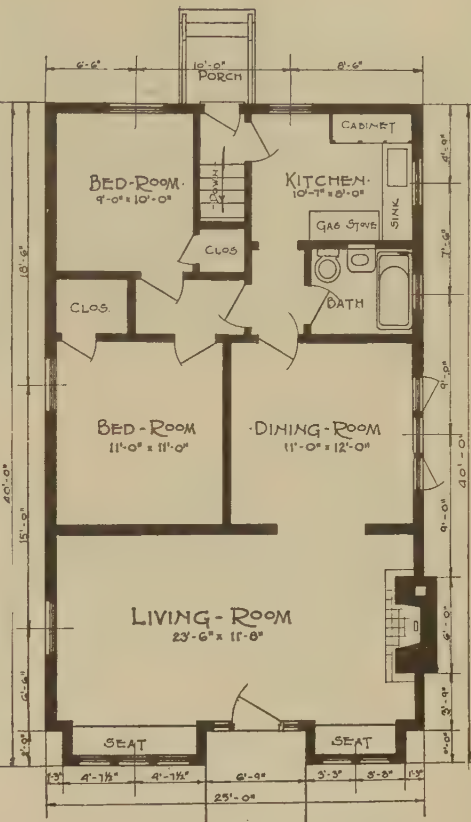


Fig. 3—Morton Grove House Plan No. 1174

The first house was started at a time when material and labor prices were at their peak and before the roof was completed enough saving had been effected to demonstrate the economy of concrete construction. Three additional houses were commenced shortly after. (See plans, Figs. 2 and 3.)

The Fellgren system of construction was used. This system has been in use for a number of years in and around Chicago and between 30 and 40 houses have been constructed by this method. The owners all acclaim them as being the best type of construction known to them. The outer walls are of 6 inch monolithic concrete on a 10 inch concrete foundation and provides a house that is practically proof against even extraordinary destructive storms. See detailed description in connection with Fig. 4.

The walls are insulated by means of an air space formed by 2x4 studding partially embedded in concrete and acting as furring strips. This is a feature of the Fellgren system and very similar to the Parrish system used in the vicinity of Pittsburgh for a number of years and discussed several years ago in detail in Concrete. The outer surface was finished with Truscon coating. Past experience has shown such houses to be easily heated in winter and remarkably cool in warm weather. The air space serves to moderate the temperature within the rooms at all seasons of the year.

These houses were all individually planned and arranged to meet the popular demand for a moderate sized house eliminating waste space and to include accommodations for an average sized family. The interior finish

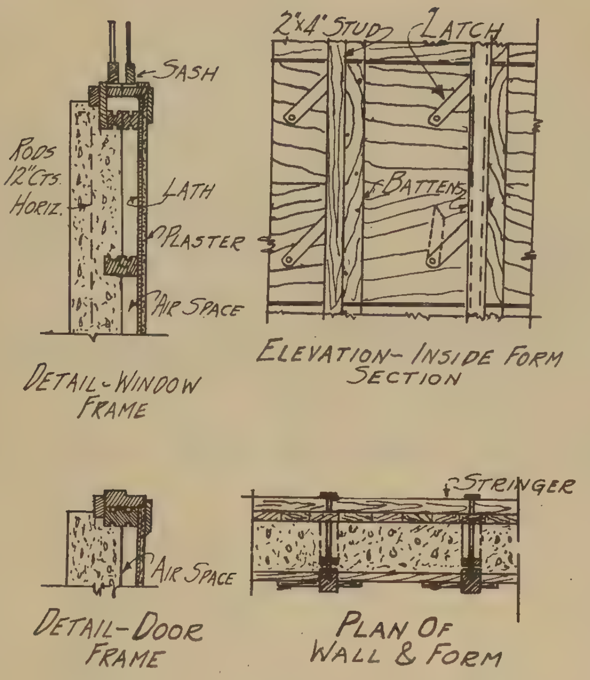


Fig. 4—Details of Fellgren System

In the Fellgren system a frame work is erected as for the ordinary frame construction. Studs are grooved on the 4 in. face and properly spaced for furring for lath. The grooves anchor the studs into the concrete and also support the inner mold boards, which occupy the space between adjacent studs. These mold boards are about square in shape and are held at any desired height by latches fitting into the grooves in the studs. The outer forms are built of one-inch lumber connected to form units by two stringers. These units are about two feet in height and any desired length, and are fastened to the studding and held at proper distance by lag screws and separators. After any layer of concrete has been placed and has become sufficiently hard, the lag screws are removed and the outer forms moved to the position immediately above. The holes made by the lag screws are filled with cement mortar when forms are removed. The walls are generally about 6 in. thick and 1½ in. of the studs extend beyond the concrete on the inside face of the wall. This provides an air space between the concrete wall and the lath-and-plaster which serves as insulation. The exterior surface of the concrete walls can be finished in any manner desired. In this system concrete work has so far been confined to wall construction, but the inventor, C. W. Fellgren, has developed the system for use in constructing floors and roofs.

is of good quality, hardwood floors, steamheat and a good grade of plumbing.

The houses are of pleasing appearance embodying only features of attractive design. Each house, and in fact the entire group emphasizes the possibilities of concrete for architectural treatment. An interesting fact is that these houses are being sold at a price of a well constructed frame house.

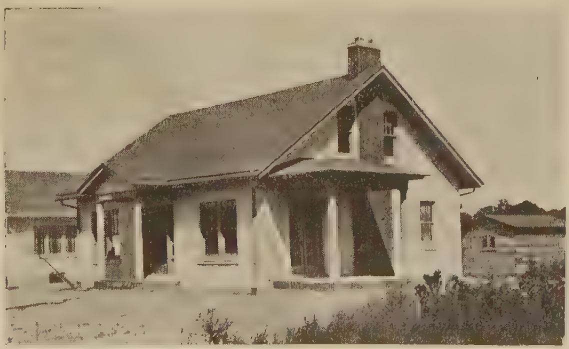
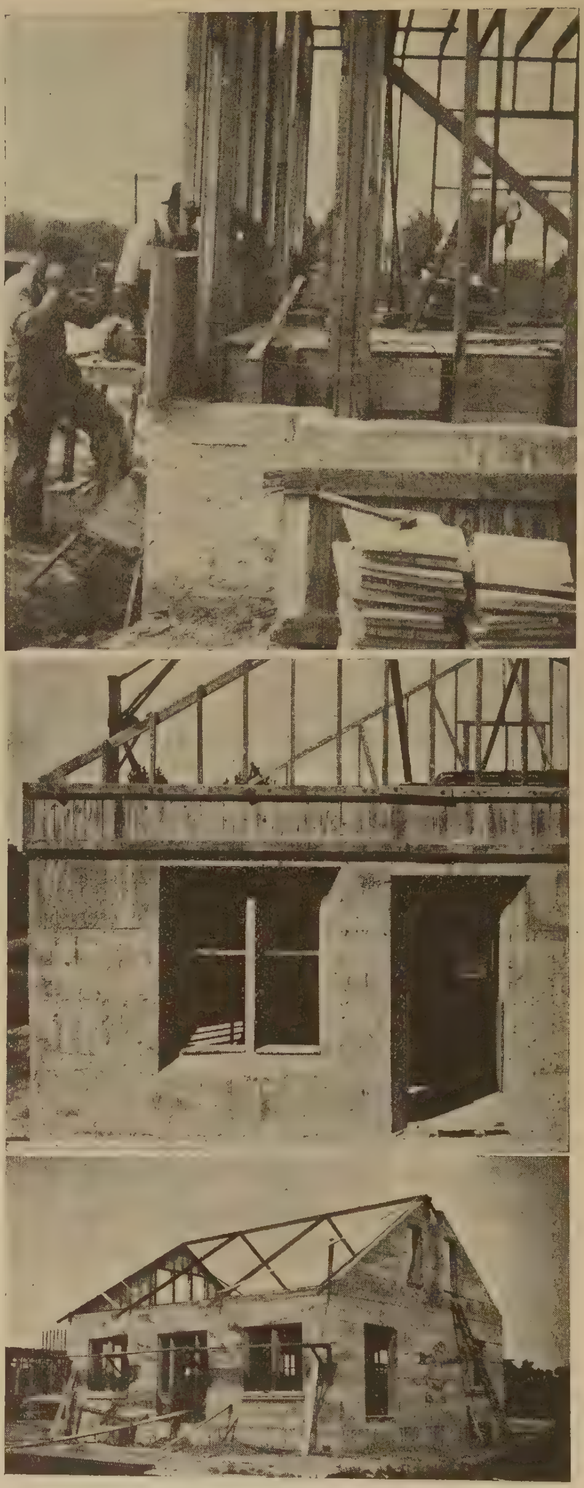


Fig. 5—This House Was Built From Plan 1140—There Are Three Bed Rooms on the Second Floor



Figs 6-7-8—Construction with Fellgren System

An accepted criterion of the fireproof value of any construction is the insurance premiums, which are determined from expert knowledge and undisputed experience of fire insurance companies. The rate on these buildings is less than that for the best type of office building in Chicago, in spite of the fact that these houses are located at the extreme limits of the town where fire protection is not the best.

Cost of Morrill Type Concrete Houses in France

General reconstruction work in France is progressing slowly, as there is little or no assurance that Germany will be made to pay the war damage. Concrete house construction is growing in favor owing to its suitability and relative economy over other masonry work.

Milton Dana Morrill, an American architect, recently returned from France, where he was engaged in reconstruction work at Lens, completed two houses by his own system.

The Morrill steel form system has been described in CONCRETE, in connection with many jobs. The form plates are used in horizontal series. Each plate is 32 in. long and 16 in. high, placed on both sides of the wall, which is poured one course at a time. After pouring the first course, a second tier of plates is placed on the first and connected to them by hinged arms of steel that act as braces. When the second course is poured, the first is lifted by means of the hinged arms and becomes the form for the third course. The inner and outer forms are held apart by spreaders of short pieces of pipe, which are driven out as soon as the forms are moved.

The recent French work done by Morrill included concrete walls and interior partitions for two houses. The exterior walls, from foundation to cornice line contain 136 sq. meters of surface (solid measure, doors and windows included). They contain 48 cu. yds. of concrete. Setting the steel forms and mixing and placing the concrete took 620 labor hours.

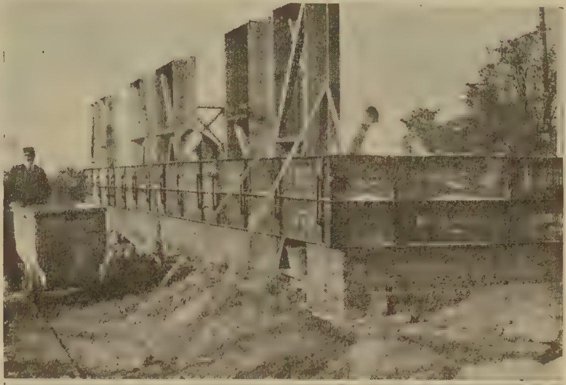
The materials and costs as reported by Mr. Morrill are:

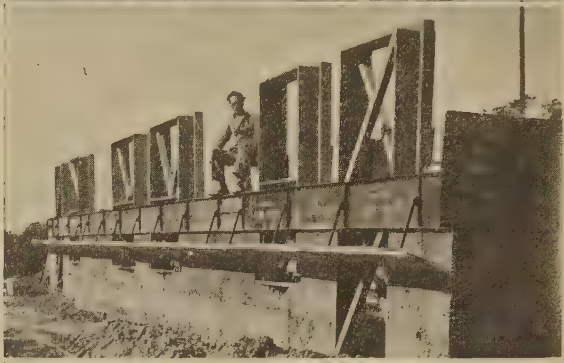
158 sacks cement at 7.10 francs	1121.80	francs
39 sacks hydraulic lime at 3.25	122.50	"
30.6 meters cube crushed brick at 12.50	387.50	"
11 meter cube sand at 18.50	203.50	"
10 meter cube aggregate (war debris) no cost		
136 meter square, rental steel forms at 3.00	408.00	"
620 labor hours at 2.08 average	1292.50	"
Total cost of walls	3535.80	francs

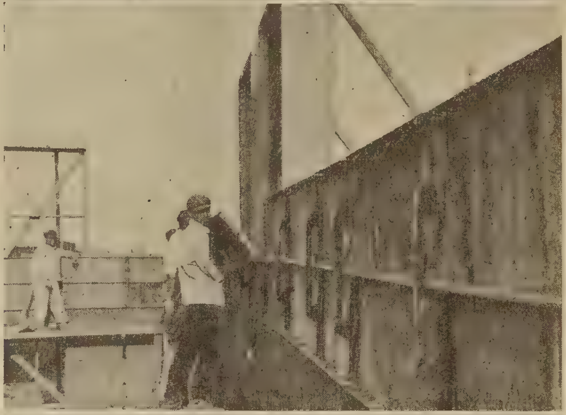
"In this work the cost of materials for the concrete was 49.60 fcs. per meter cube. The cost of all labor, mixing and placing concrete (by hand) came to 35.0 fcs. per meter cube," says Mr. Morrill. "This included the labor cost of setting the steel forms, which was 0.50 fcs. per surface meter, or square meter of form set. To this must be added the form rental at 3.00 fcs. per square meter (exterior measurement of house walls), which was 11.00 fcs. per cubic meter of concrete.

"The total cost of the walls amounted to 95.60 fcs. per meter cube. The best cost obtained for brick masonry work even on construction jobs, including 850 houses, where wholesale methods were applied, is 120 fcs. This shows a 20% saving in favor of concrete. It seems possible that were machine mixing and hoisting used and the laborers more accustomed to this work that an economy of 30% or 40% could be obtained over brick work.

"In many places, including Lens, skilled brick masons are difficult to find and the ample supply of unskilled labor suitable for concrete work is another argument for this type of construction."







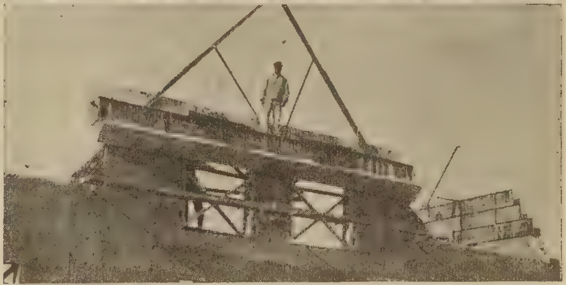


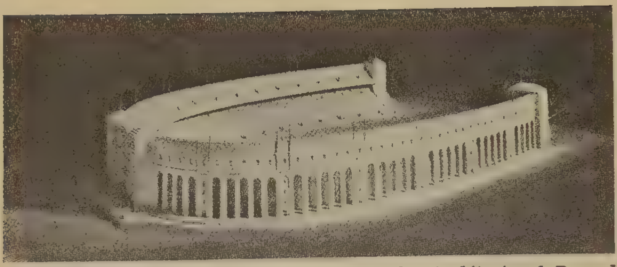
FIG. 1—THREE COURSES IN AND FRAMES SET—MORRILL SYSTEM, LENS, FRANCE

FIG. 2—FORMS LOOSENED FROM WALL AND READY TO BE SWUNG UP

FIG. 3—SWINGING UP THE FORMS—PIPE SPACERS LEAVE SUPPORTS FOR SCAFFOLD BRACKETS

FIG. 4—CONCRETE ALL THE WAY UP INTO THE GABLES

Don't overlook the Information Service which CONCRETE maintains. If you have a problem, let's talk it over.



Courtesy *The Architectural Record*

Fig 1—From a Model of the Stadium Being Constructed for Ohio State University, Columbus

Building Ohio State Stadium

How Materials Are Handled—Outstanding Design Features

By Charles W. Dair
Assistant Field Engineer
Ohio State University Stadium

The last of the foundations for the new Ohio State University Stadium at Columbus were poured early in December, 1921. Foundation work had progressed so rapidly that it was possible to pour a section of the seat banks in the favorable weather. The section poured consists of three rows of boxes and nine rows of seat risers for a length of about one-half of the east leg of the horseshoe.

The central mixing plant is located just outside of the east leg of the horseshoe, where a one cubic yard Smith concrete mixer is elevated so that it can be discharged into batch buckets on narrow-gauge cars below. The sand and gravel storage bins are on the east side of the plant, elevated so as to discharge into a batch hopper on the charging floor above the mixer. The cement is in bulk and is stored directly above the charging floor.

The cement storage bin is 15x24 ft. and holds about 800 bbls. It has a hopper bottom, which discharges through a measuring box into the batch hopper. This measuring box is two feet square with sliding iron gates at the top and bottom. With the bottom gate in place and the upper one open, the hopper gate at the bottom of the cement storage bin is opened and the box allowed to fill to about two inches above the upper gate. The upper gate is then closed and the lower one opened, allowing the cement to slide down into the batch hopper on top of the aggregate. When it is desired to change the mix, which necessitates changing the cubical contents of the measuring box, solid blocks are bolted to the inside of the box.

The charging of the sand and gravel storage bins is done directly from the cars by a clam-shell attached to a stiff-leg derrick.

The bulk cement is shoveled from the car doors into a small hopper feeding a screw conveyor, which carries the cement about twenty-five feet to the bottom of a chain and bucket elevator shaft, by means of which the cement is elevated to the top of the storage bins, a distance of 50 ft. A $7\frac{1}{2}$ h.p. motor drives the chain and bucket elevator and the screw conveyor.

Two men were stationed on the charging floor to measure the water, cement and aggregate and charge the mixer. One man was on the floor below, in charge of the mixer. The engineer kept one man at the plant to oversee the measuring of materials and the quantity of water used, and to see that the materials were thoroughly mixed.

There were two tracks around the entire structure, a narrow-gauge track about 20 ft. outside the outer line of foundations, and a standard-gauge track 25 ft. in from the outside line. The concrete was transported from the mixing plant to the forms in Insley open-bottom batch buckets. These buckets were handled on Lakewood in-

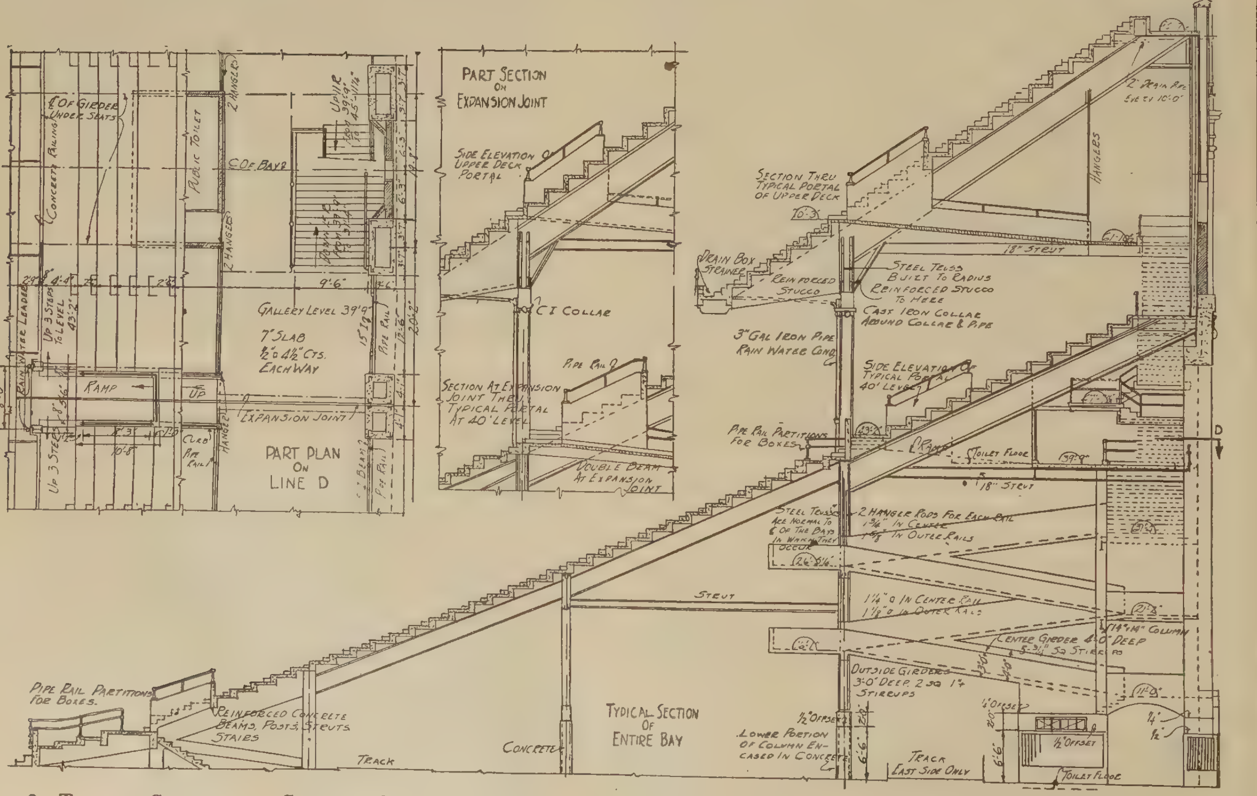

℄ Of Girder Under Seats
Concrete Railing
Public Toilet
℄ Of Bays
2 Hangers
Up 11 R
Down
Gallery Level 39'9"
7" Slab
½" ▫ 4½" Cts.
Each Way
Rain Water Leader
Up 3 Steps To Level 43'2"
Ramp
Up
Expansion Joint
Curb
Pipe Rail
Hangers
Up 3 Steps
Part Plan On Line D
Beam
Pipe Rail
Part Section On Expansion Joint
Side Elevation Of Upper Deck Portal
C I Collar
Pipe Rail
Section At Expansion Joint Thru Typical Portal At 40' Level
Double Beam At Expansion Joint
Section Thru Typical Portal Of Upper Deck
2" Drain Pipe Every 10'0"
Hangers
18" Strut
Drain Box Strainer
Reinforced Stucco
Steel Truss Built To Radius
Reinforced Stucco To Here
Cast Iron Collar Around Collar & Pipe
3" Gal Iron Pipe Rain Water Cond
Side Elevation Of Typical Portal 40' Level
Pipe Rail Partitions For Boxes
Ramp
Toilet Floor
18" Strut
D
Steel Trusses Are Normal To ℄ Of The Bays In Which They Occur
2 Hanger Rods For Each Rail
1¾" In Center
1⅝" In Outer Rails
Strut
1¼" ▫ In Center Rail
1⅛" ▫ In Outer Rails
14"x14" Column
Center Girder 4'0" Deep
Outside Girders 3'0" Deep 2 ▫ 1" Stirrups
Pipe Rail Partitions For Boxes
Reinforced Concrete Beams, Posts, Struts Stairs
Track
Concrete
Typical Section Of Entire Bay
½" Offset
Lower Portion Of Column Encased In Concrete
Track East Side Only
½" Offset
Toilet Floor

Fig 2—Typical Sections of Stadium Showing Structural Features

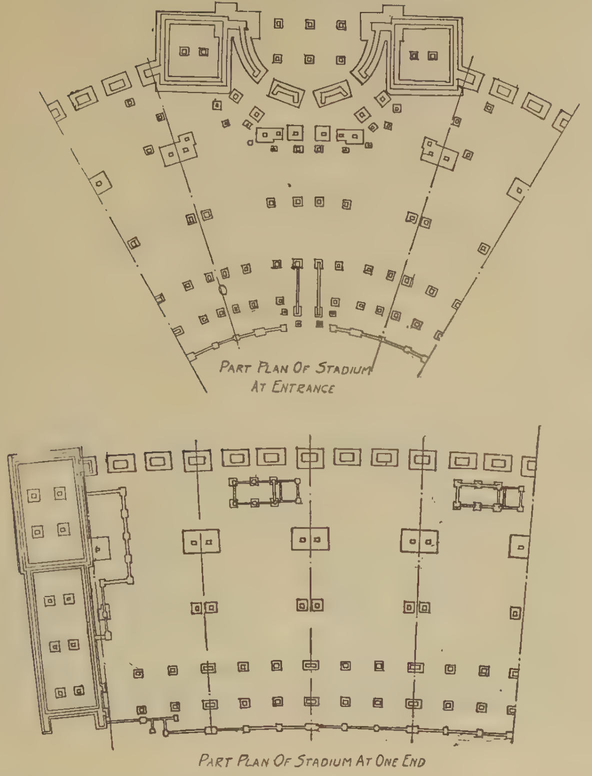
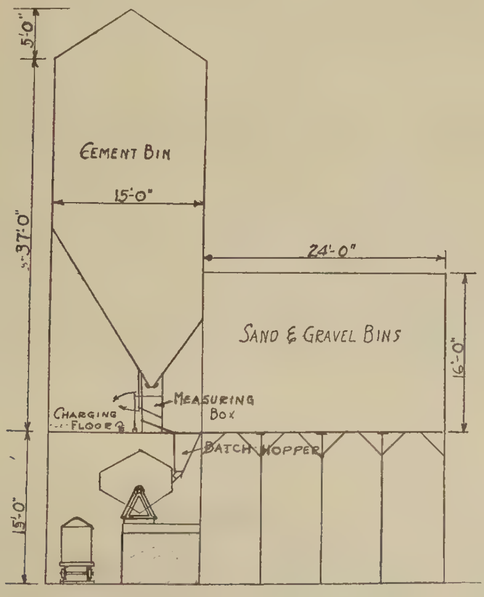

PART PLAN OF STADIUM AT ENTRANCE
PART PLAN OF STADIUM AT ONE END

FIG 3—TWO PARTIAL PLAN VIEWS—END AND CENTER, THE LATTER, INCLUDING ENTRANCE

dustrial railway cars with an American gasoline locomotive. For the big foundations, where the concrete could be handled fast enough, two locomotives were used. When pouring on the west side, which required a long haul, three trains of two cars and four buckets each were used. One train was kept under the mixer at all times. The batch buckets were lifted from the industrial cars directly to the foundation forms by a Browning locomotive crane, which was on the standard-gauge track. The buckets were opened directly into the forms and the concrete puddled into place. For the inner line of foundations, which could not be reached by the crane, buggies were used. The consistency of the concrete necessitated a puddling gang of five or six men.



SKETCH THRU MIXING PLANT
FIG. 4—THE STORAGE BINS AND MIXING PLANT

The seat banks were poured from a Lakewood chute, supported at both ends by moving towers. The chute followed the pitch of the seat banks, with an opening above every second riser. The concrete was placed in a hopper on the high tower by the locomotive crane, from which hopper the flow in the chute could be regulated. The specifications do not permit chuting directly into the forms so buckets were suspended from the bottom of the chute at the openings and the concrete dumped, from them into the forms. These buckets were made with a semi-circular bottom, so as to be emptied in either direction.

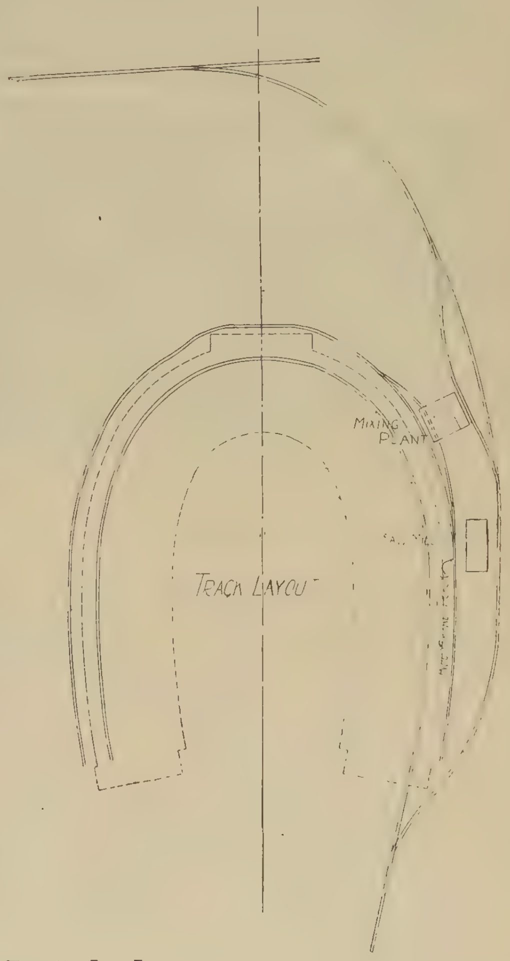


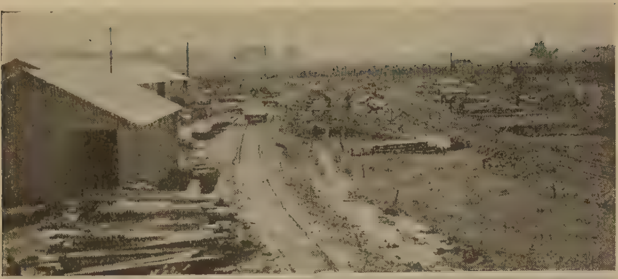
FIG. 5—JOB LAYOUT

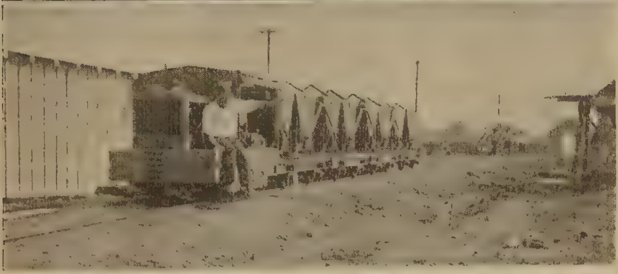
After pouring the seat banks, the concrete work was stopped until early spring. The erection of the structural steel framework has been started and will continue throughout the winter.

The finished structure will consist of 25,000 cu. yds. of reinforced concrete and 4350 tons of structural steel; 5500 cu. yds. of concrete have been poured to date.

The accompanying pictures show the equipment and layout. A line sketch shows a section through the mixing plant—the storage bins and the cement measuring box. The track layout shows the system of tracks used around the entire structure.

In connection with the design of the Ohio Stadium, three principal features distinguished it from other structures of its class—(1) the double deck, (2) the bowed





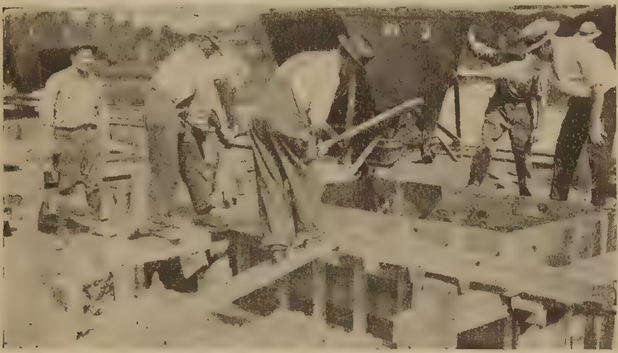


Fig 6—East Leg of Horseshoe from Mixing Plant

Fig 7—Hauling Empty Concrete Buckets Back to Mixer

Fig 8—Pouring Concrete In Footings

or curved sides with an open end and (3) the extensive use of the space under the lower deck. These are pointed out by the designer, Howard Wright Smith, in *The Architectural Record*. From Mr. Smith's article Concrete quotes as follows in reference to structural features:

Structural System

The acceptance of concrete, both plain and reinforced, as the most effective material for large operations both for economy and facility of construction has presented new problems for the designer as well as for the engineer. The science of concrete slab and beam construction has been as standardized as that of the rolled steel section. For the engineer, however, the two great problems involved in concrete construction of great size are first the necessary inspection to insure laboratory perfection of execution ,and second the location and design of expansion joints. The first only affects the architectural designer insofar as it should influence him in avoiding the creation of intricate or impossible conditions.

The problem of expansion joints, however, has come to be as important for the architectural designer as for the structural engineer. Experience of the past decade has proven that in large operations it is impractical to conceal expansion joints. Experience also shows that simple butt joints in single planes are most effective and present the least difficulties in maintenance.

Consequently, the structural system employed in the design of the Ohio Stadium is that of building integral sections consisting of three bays each, which measure sixty feet along the face of the outside wall. The central portion of the main entrance forms a structural unit. Each of the towers on either side of the entrance arch and the two at the south ends of the structure also form separate units. Thus the Stadium consists of thirty-four separate and distinct units which have nothing in common except footings. Pier dimensions and arch spans in the exterior wall have been so proportioned as to accomodate the joints between adjoining units without any over-lapping or slip joints. The vertical supports at these expansion joints are all doubled so that girders and beams of each section may be supported entirely by elements of the units in which they occur. This is an amplification of the successful system used in the substructure of the Harvard Stadium, where girders of each section bear upon piers located about three feet from each end, with the girders of adjoining sections butting together leaving a 6-foot space between the adjacent columns.

The only extraordinary features of structural design involved are the heavy girders spanning the 60-foot space between the columns which support the upper deck, and the design of these coupled columns to make them as thin as possible in order to obstruct as little as possible the view of the playing field from the seats in the upper portion of the lower deck.

The upper deck is constructed largely of steel, much after the scheme of the entire Harvard Stadium. Precast seats in short lengths are used, and the steel work is protected with cement. The entire lower deck is constructed as a sloping roof slab, in order to form proper protection to the space below. On this roof slab are placed precast seat sections, in short lengths, resting on lugs cast in the sloping slab. A system of seat drainage is provided, with catch basins at numerous intervals throughout the cross section in order to prevent the weathering effect of water washing down over great areas of seats. Gutters are provided under expansion joints, to take care of the unavoidable leakage at those points. The stairways of the vertical circulation system are of firescape construction. The footings for the entire structure rest on the gravel of the former bed of the Olentangy River, which now flows to the west of the entire recreation field.

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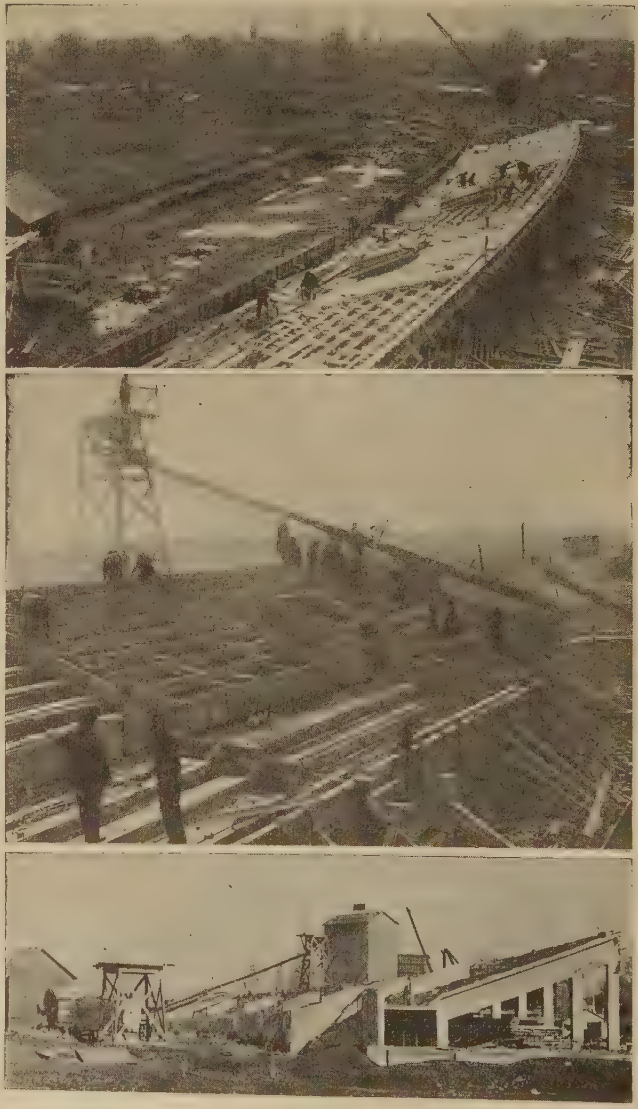


Fig 9-11—Construction Progress Ohio Stadium

Concrete for Mines and Mine Buildings

Some Applications for Concrete in Northern Michigan Iron Mines —Continued From March CONCRETE

By B. G. Best

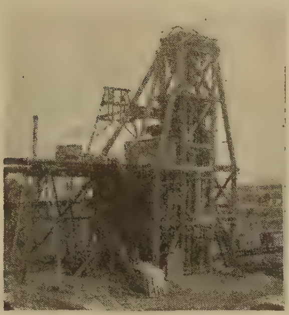


Fig. 20—Left—Timber Headframe, "C" Shaft, Pabst Mine

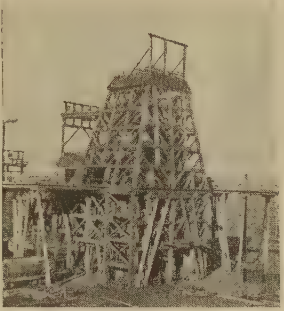


Fig. 21—Right—Timber Headframe, "C" Shaft, East Norrie Mine (Dismantled), the Type of Structures Being Replaced by Concrete Frames

Headframes

The first headframes used were simple in design and construction, built of timber and usually erected by the mine carpenters. The headframes at "C" Shaft, Pabst Mine, and "C" Shaft, East Norrie Mine, shown in Figures 20 and 21, are of a later type. The Pabst headframe was built in 1898 to serve a three compartment vertical shaft and is one of the few old timber headframes still in use on the Gogebic Range. The main members are 16″ x 16″ fir. The East Norrie headframe was erected at about the same time but was dismantled a few years ago when the shaft was abandoned. Timbers 16 in. x 16 in. and 14 in. x 14 in. were used in this structure, which for about 20 years withstood the effects of high speed hoisting from depths as great as 1,200 ft. When the headframe was torn down the condition of some of the timbers was such that they were used on other work. The timber headframe, however, is a thing of the past, and except in exploratory or development work or in small operations, has been superseded by the steel headframe. A modern steel headframe, erected by the American Bridge Co. at "H" Shaft, Pabst Mine, is shown in Fig. 22. A steel headframe weighs between 150 and 200 tons, and is usually built on concrete piers, 10 to 15 in number and containing from 100 to 150 cu. yds. of concrete.

Fig. 23 shows the steel headframe at the Penn Iron Company's Curry Shaft, Vulcan, Mich., which was reinforced with concrete to withstand the strains caused by the addition of a crushing plant.

Tower for Crushing Plant, Brier Hill Shaft, Vulcan, Mich.

At the Penn Company's Brier Hill Shaft it was necessary to build a tower near the headframe to house a crushing plant. This tower, of reinforced concrete, is shown in Fig. 24. The Brier Hill is a circular concrete shaft. The ground at the collar is a sand fill. The bottom of the foundation for the tower is 5 ft. below surface and the top of the tower is 96 ft. 6 in. above ground, making a total height of 101 ft. 6 in. The foundation is a 27-in. ribbed slab, 25 ft. x 31 ft., with intersecting ribs 30 in. wide and 33 in. high. For a distance of 51 ft. above the ground the columns are 30 in. x 30 in. At this point they are reduced to 24 in. x 24 in. and later to 18 in. x 18 in., at which size they continue to the top of the structure. All the columns are of concrete reinforced with old hoisting rope. The girders are 18 in. x 48 in. Floor slabs are six and eight inches thick. Below the crusher elevation six and ten-inch concrete walls stiffen the structure and form a storage space. A 1:2:4 mixture was used almost entirely.

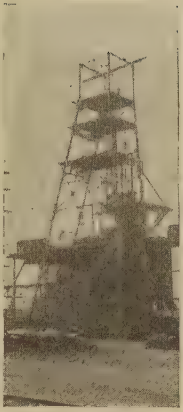


Fig. 22—Left—Steel Headframe, "H" Shaft, Pabst Mine

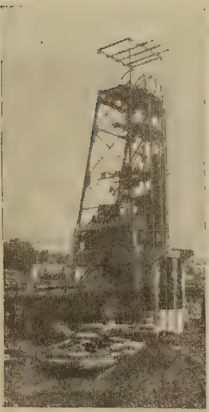


Fig. 23—Center—Steel Headframe Strengthened by Addition of Concrete

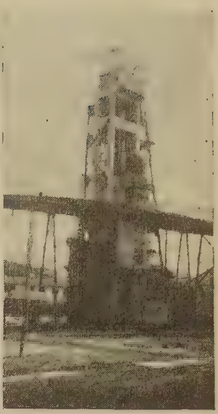
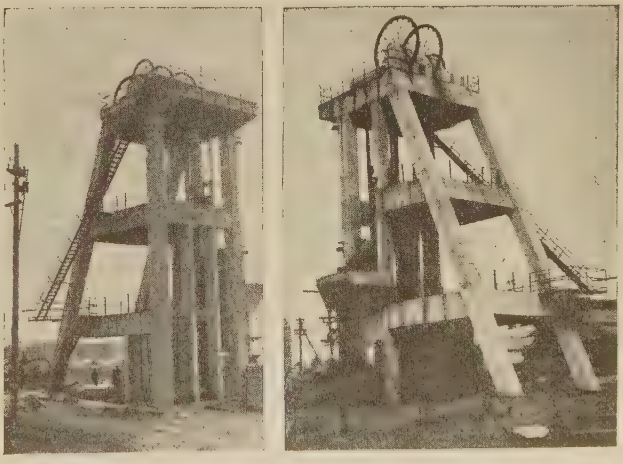


Fig. 24—Right—Concrete Tower for Crushing Plant, Brier Hill Shaft

Concrete Headframes, Penn Iron Co., Vulcan, Mich.

Figures 25 and 26 show the reinforced concrete headframe at the Penn Iron Company's West Vulcan Mine, Vulcan, Mich. This structure is 60 ft. high from the collar of the shaft to the center line of the sheaves. The foundation is of heavy concrete girders and piers. The main columns are 30 in. x 30 in. and the principal girders 15 in. x 48 in. The greater part of the reinforcement is discarded hoisting rope.

The concrete headframe at the Penn Company's East



Figs. 25 and 26—Front View—Reinforced Headframe, West Vulcan Shaft; Right—Rear and Side View

Vulcan Mine is an enlarged continuation of the shaft lining extending from a point 75 ft. below surface to a height of 30 ft. above the ground. A casual observation reveals nothing more than a rectangular concrete structure about 20 ft. square and 30 ft. high, built on the side of a hill. A careful inspection, however, will show that this is merely the top of a structure 105 ft. high, in which all of the ore hoisted in this shaft is transferred into cars operating in a haulage level which is 60 ft. below surface at the shaft and runs from this point to the surface ore bins located some distance down the hillside. Like the West Vulcan headframe, this structure was reinforced with discarded wire hoisting rope.

The crushing tower at the Brier Hill and the two concrete headframes of the Penn Co. were built by regular mine crews.

Concrete Headframes, Cleveland-Cliffs Iron Co., Ishpeming, Mich.

Perhaps the two largest concrete headframes in the Michigan iron districts are those constructed by the Cleveland-Cliffs Iron Co. at Ishpeming, Mich. These headframes are described in the *Transactions of the American Institute of Mining and Metallurgical Engineers* by J. Ellzey Hayden and Lucien Eaton. An abstract of the paper appeared in the December, 1920, issue of Concrete. Both headframes were built outside of old wooden headframes which they were to replace and which were to be used for hoisting purposes during the construction of the new headframes. Construction was completed with only four hours' delay in hoisting.

Shafts and Shaft Lining

The development of shaft lining has been similar to that of mine structures. For many years timber sets, lathed with plank or poles, were used. It has been estimated that the life of a timber shaft is from 12 to 15 years, with minor repairs after six or eight years. This means an increasing expense after the first six or eight years, due to the high cost of timbering and the loss of income. Partly for this reason and partly as protection against fire, in several shafts steel rails were used in place of wooden timbers. Later, structural shapes replaced the rails because they were easier to handle and gave better service. I-beams, channels, angles and H-sections were tried out in various shafts, with the result that the H-section has been accepted by several companies as the most desirable steel shaft lining. With the sinking of permanent fireproof shafts concrete lath and poured concrete walls have been used with steel sets in the place of plank lining.

In the past 10 years the Oliver Iron Mining Co. has sunk three five-compartment shafts, with steel sets and precast concrete lath, at Ironwood, Mich. The first of these was "New C" Shaft at the East Norrie Mine, replacing old "C" Shaft, which was abandoned. This shaft is inclined at 64° with the horizontal and is 1,405 ft. in depth. The second shaft was "E" Aurora, inclined at 68° and 1,162 ft. deep. "H" Shaft, Pabst Mine, was started in the latter part of June, 1917, and March 20, 1919, was completed to a depth of 1,830 ft. As shown by Fig. 27 the shaft is 11 ft. 4 in. x 18 ft. 4 in., outside measurements. The cage compartment is 5 ft. 8 in. x 10 ft., the two skip compartments 5 ft. x 6 ft., and the ladder and pipe compartments 3 ft. 8 in. x 5 ft. The wall plates, end pieces and dividers are 8 in. 34-lb. H-beams, and the cross, or sub dividers, 4 in. 13.6-lb. H-sections. The studdles are 3½ in. x 2½ in. x ⅜ in. angles, 4 ft. 4 in. long. The sets are spaced 5 ft. apart, center to center. Bearers, consisting of four 12 in. 31.5-lb. I-beams, 17 ft. long and spliced in the middle to make handling and installation easier, were placed every hundred feet. This type of set with 3 in. precast concrete lath was used to a depth of 650 ft., below which depth the nature of the ground was such that lighter timbering was used, 6 in. 23.8-lb. H-beams being substituted for the 8 in. sections and 2½ in. lath used in place of the 3-in. slabs. Riveted to the upper and lower sides of the web of each wall plate and end piece are two angles, 3½ in. x 2½ in. x ¼ in., which, with the outside flanges of these sections, form recesses in which the slabs are placed. All slabs are made of 1:2:4 concrete and reinforced with two rows of ¼ in. round rods.

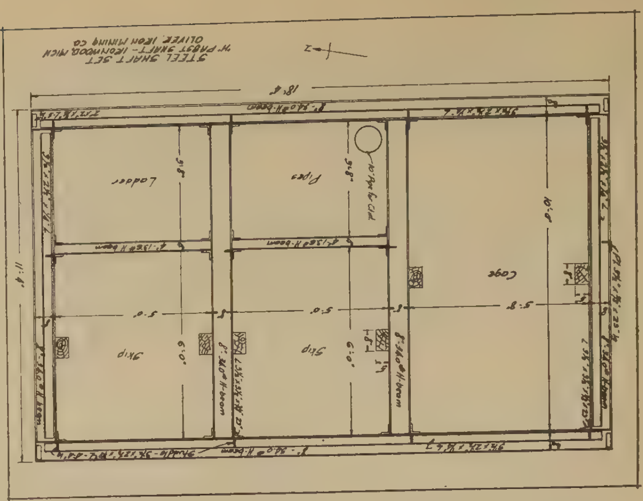


Fig. 27—Steel Shaft Set, "H" Pabst Shaft

When the shaft was started the mixing plant used at "C" Shaft, East Norrie Mine, was moved to the Pabst and erected a short distance from the shaft. The plant is completely enclosed in a frame building about 87 ft. long and 15 and 30 ft. wide, in one end of which are bins for sand and crushed rock. A gangway runs from these bins to a mixer located at the side of a track running through the center of the building. Cement is stored on a platform behind the mixer. In pouring the slabs forms are placed on a track, run to the mouth of the mixer, and the concrete poured directly into the forms. Rods cut to the required length are placed near the mixer so that little time is lost placing the reinforce-located on both sides of the track, the slabs placed thereon and after the upper surface of the slabs has been troweled, are allowed to remain in the forms for 24 hours at a temperature between 75° and 80° Fahr. They are then taken out of the forms and seasoned for three weeks before being used.

Later a crushing plant was erected near the mixing plant and granite from the shaft was used in making the slabs. The crusher is still in operation and crushed rock is being supplied for other work.

The first slabs used were cast in forms used at the East Norrie shaft. These forms were of three sizes and made of steel plate and angle irons. The forms for slabs *A*, *D* and *E*, to be described later, were 4 ft. 10½ in. long, 8 in. wide and 3 in. deep inside. The base was a ⅜ in. steel plate 13 in. x 5 ft. 3½ in., along the sides of which were bolted two 3 in. x 2½ in. x ¼ in. angles, the long sides vertical and toward the center of the plate. Two similar angles, 8 in. long, were bolted to the ends of the plate between the longer angles. At each end of the form the two long angles were held together by a ⅝ in. x 9¼ clamp bolt. The forms for slabs *B* and *F* were similar except in size, the plate being 14$\frac{15}{16}$ in. wide and the inside width of

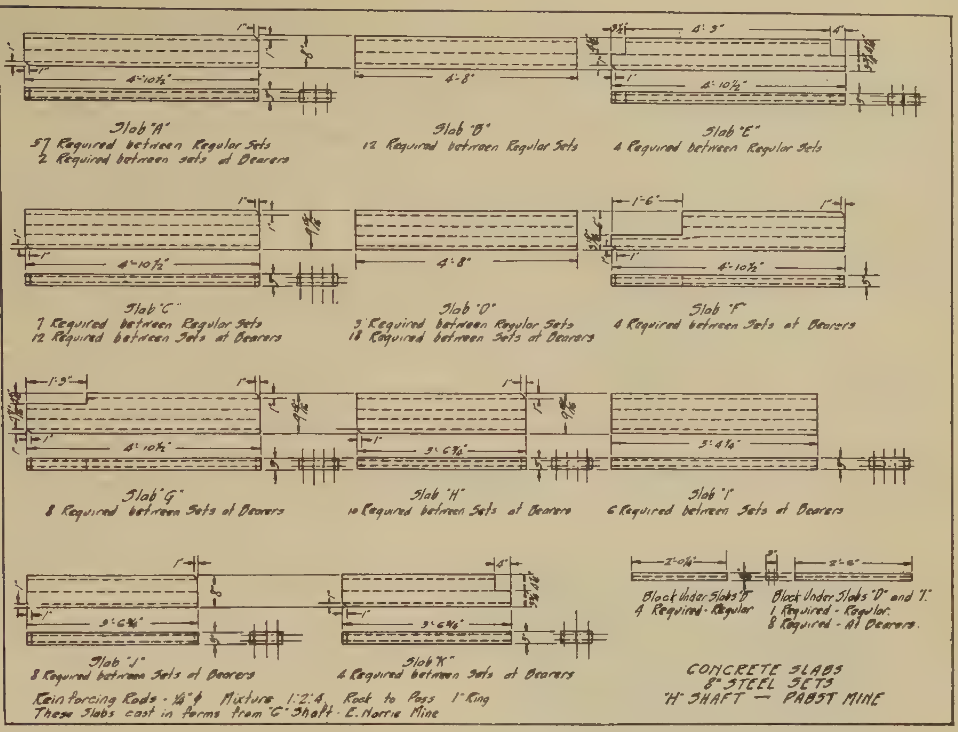

1"
8"
4'-10½"
Slab "A"
57 Required between Regular Sets
2 Required between sets at Bearers
4'-8"
Slab "B"
12 Required between Regular Sets
9½
4'-3"
4"
4'-10½"
Slab "E"
4 Required between Regular Sets
$9\frac{1}{16}$
4'-10½"
Slab "C"
7 Required between Regular Sets
12 Required between Sets at Bearers
4'-8"
Slab "D"
3 Required between Regular Sets
18 Required between Sets at Bearers
1'-6"
4'-10½"
Slab "F"
4 Required between Sets at Bearers
1'-9"
4'-10½"
Slab "G"
8 Required between Sets at Bearers
3'-6¾"
Slab "H"
10 Required between Sets at Bearers
3'-4¼"
Slab "I"
6 Required between Sets at Bearers
3'-6¾"
Slab "J"
8 Required between Sets at Bearers
4"
3'-6¾"
Slab "K"
4 Required between Sets at Bearers
2'-0¼"
2'-6"
Block Under Slabs "B"
4 Required - Regular
Block Under Slabs "D" and "I"
1 Required - Regular
8 Required - At Bearers
Reinforcing Rods - ¼" ϕ Mixture 1:2:4 Rock to Pass 1" Ring
These Slabs cast in forms from "G" Shaft - E. Norrie Mine
CONCRETE SLABS
8" STEEL SETS
"H" SHAFT — PABST MINE

Fig. 28 — Concrete Slabs, "H" Shaft, Pabst Mine

the form $9\frac{15}{16}$ in. A ⅝ in. x $11\frac{1}{4}$ in. clamp bolt was used with this form. For slabs *C* and *G* the plate is 5 ft. 4 in. x $11\frac{1}{2}$ in., making a form whose inside measurements are 4 ft. 11 in. x $6\frac{1}{2}$ in. The clamp bolt is $7\frac{3}{4}$ in. long. The inside of the forms was free from rust and scale, and in addition was given a coat of oil before the concrete was poured.

Using the forms described above five sizes of slabs were necessary between regular sets, and six additional sizes between sets of bearers. These slabs are shown in Fig. 28. By using wood filler pieces in the steel forms eleven sizes of lath were cast in three sizes of forms. So that the lath could be placed in position more easily, some of them—*A, C, E, F, G, H, J* and *K*—were cast with diagonal corners. To fit around the steel, irregular slabs—*E, F, G* and *K*—were used. The blocks used under slabs *B, D* and *I* were cast in wooden forms made at the mine. Between regular sets 83 slabs were required and between sets at bearers 72 were used. Between regular sets the first slabs were placed at the ends of the wall plates. Working from both ends 24 *A* slabs were placed by inserting them in a diagonal position between the angle iron and the outside web of the H-beam and turning them until vertical. A concrete block $1\frac{3}{4}$ in. high and 2 ft. ¼ in. long was placed on the web of the lower steel set between the *A* slabs previously placed and three *B* slabs placed between the *A* slabs by inserting the upper ends in the recess in the upper wall plate, lifting the slabs high enough to clear the lower angle, and dropping them into place on the blocks. In this manner both ends of the slabs were held by the angle irons. At the east end of the south end piece one *E* slab was placed with its edge against the side of the *A* slab at the end of the wall plate. Two *C* slabs were placed on the east side of the studdle and the space between these and the *E* slab filled with three *B* slabs placed on blocks as before. On the west side of the studdle three *A* slabs were placed, and against the *A* slab at the end of the west wall plate one *E* slab was placed, followed by two *A* slabs. The space between the two groups of *A* slabs was filled with three *B* slabs. When all the slabs were placed they occupied the following order, beginning at the east end of the end piece: *E, B, B, B, C, C,* (studdle) *A, A, A, B, B, B, A, A* and *E*. Beginning at the east end of the north end piece the slabs were placed in the following order, the *D* slabs being placed last: *E, A, A, C, C, C, C, C, D, D, D, A, A* and *E*. Between sets at bearers the slabs were placed on the wall plates, beginning at the south end of the shaft, in the following order: *F, D, D, D, C, C, A, G, G, D, D, D, C, C, G, G, D, D, D, C, C* and *F*. Beginning at the east end the slabs were placed on the end pieces in this order: *K, J, J, H, I, I, I, H, H, H, H, J, J* and *K*.

To increase the output of the mixing plant forms which had been used at the Sibley Mine were shipped to the plant at the Pabst. The slabs made in these forms were not of the same sizes as those made in the East Norrie forms, but in other respects were similar and were placed in much the same manner. Minor changes in the slabs were necessary when the 6 in. steel was used. The thickness of the slabs was reduced to $2\frac{1}{2}$ in. and a few other changes made so that the slabs would fit around the steel.

The steel and slabs were delivered to the shaft by team, lowered in the sinking buckets or on the cage and placed by the shaft miners. The shaft crew consisted of eight miners and one boss per shift. Three eight hour shifts per day were worked. These eight men did all the drilling, blasting, mucking, placed steel and concrete lining, cut hitches and placed bearers and installed guides. On the day shift they were assisted by one or two timbermen, who helped place the steel and concrete, but who spent most of their time installing ladders and collars and cleaning the shaft. To handle a steel set required about $3\frac{3}{4}$ hours and placing the lath took $1\frac{3}{4}$ hours, making a total of $5\frac{1}{2}$ hours per set. Steel was kept within 15 or 20 ft. of the bottom of the shaft and none of the sets were injured by blasting. From surface to ledge, a distance of 40 ft., wooden lath were used until the shaft was deep enough so that the blasting would not damage the concrete lath. The wooden lath were later replaced by concrete lath, behind which concrete was poured to keep out surface water.

PALMS SHAFT, BESSEMER, MICH.

The Palms Shaft of the Steel and Tube Co. of America, at Bessemer, Mich., is a vertical shaft lined with steel sets and poured concrete. The following abstract from a paper by Frank Blackwell, now chief mining engineer of the McKinney Steel Co., Ironwood, Mich., presented at a meeting of the Lake Superior Mining Institute, describes the design and construction of the shaft.

The shaft is divided into five compartments: a cage compartment 6 ft. 2 in. x 10 ft. 0 in.; two skip compartments 4 ft. 10 in. x 6 ft. 0 in. each; a ladder compartment 3 ft. 8 in. x 4 ft. 10 in., and a pipe and counterweight compartment 3 ft. 8 in. x 4 ft. 10 in. It is 10 ft. 10 in. x 17 ft. 6 in. in outside dimensions. The wall plates, 17 ft. 6 in. long, and the end pieces and the two dividers, each 10 ft. 0 in. long, are 5 in. 18.7 lb. H-sections. The other two dividers, 4 ft. 10 in. long, are 4 in. 13.6 lb. H-sections. The eight studdles are 3 in. x 3 in. x ¼ in. angle iron. Most of the sets are placed 8 ft. 0 in. on centers. Because of the heavy ground encountered several sets are placed 6 ft. 0 in. apart and a few of them 4 ft. 0 in. The wooden guides are 5¾ in. x 7¾ in.; two of them are strengthened by 7 in. channel iron.

Some of the steel sets were riveted together on surface. Where the rock was sufficiently hard so that a distance of 14 ft. under the last set was available, the set was lowered entire and swung into place. Shoes on the two lower corners guided it through the shaft. Four one-ton duplex chain blocks were used for swinging it into place. To each corner of the set was fastened a ½ in. sling chain about 3 ft. long, with a 5 in. ring on one end and a 3 in. ring on the other, and to these the hooks of the chain blocks were attached. If the distance under the last set in the shaft was less than 14 ft. the sets were lowered in parts and bolted together in the shaft. For blocking the sets a supply of wood sprags of different lengths was always ready on surface for immediate use.

When the solid rock was more than 8 or 9 in. from the steel sets, 4 in. tie timbers were placed vertically 4 in. outside the sets and about 2 ft. apart. Between the steel sets and these timbers 4 in. wood blocks 12 in. long were placed. One-inch rough boards were placed horizontally outside the verticals to act as outside forms for pouring concrete. Lagging was filled in between the boards and the solid rock. When the rock was less than 8 or 9 in. from the sets 4 in. flat timbers were placed between the flanges of the H section sets, and lagging placed behind to the rock. This lagging was left until concreting time, when it was removed and hoisted to surface. In the two ends of the shaft the rock was from 2 to 8 in. from the steel sets for nearly the whole distance. In the other two sides the rock was 9 in. or less from the wall plates for about one-half the whole distance.

During the sinking, every 75 to 100 ft. two or three adjacent sets were filled in to the solid rock with concrete; this made it unnecessary to cut hitches and place steel bearers. This concrete also serves as a permanent support to the shaft. It was mixed on surface and lowered in a hopper at the bottom of which was a flexible spout.

When the shaft was sunk to a depth of 1,207 ft., it was thought necessary to complete the concreting because of the approach of cold weather. Concreting was started at a depth of 1,170 ft. The 1:3:5 concrete was mixed in a half yard electric driven mixer, and conducted through a launder to a 4 in. flanged pipe laid from surface. The lower end of the 4 in. pipe telescoped into a 5 in. branch. This 5 in. branch took the blow of the concrete. To the bottom of the branch was connected a reverse bend with its lower end vertical. A flexible spout 18 ft. long which fitted over this conducted the concrete to the forms. While the concreting force was filling one set, other men were removing the blocking from the set above as explained, hanging the strands of old wire rope vertically 1 ft. apart, and horizontally about 3 ft. apart for reinforcement, and placing the inside forms. For an 8 ft. span 2 in. hardwood plank was used, and for 4 ft. and 6 ft. spans 1⅝ in. hardwood plank. The plank was cut on a bevel on the upper end, so that the concrete came underneath the steel sets for a support. The bottom end came tight against the outside flange of the H-section. Two-inch strips of wood about 12 in. long were laid 1 in. apart between the bottom end of the plank and the inside flange of the steel. When these strips were taken out the planks were easily removed from the concrete.

In all cases the corners were left open for a distance of at least 12 in. from the corners of the sets. This left a solid column of concrete in each corner for the entire depth of the shaft. Also where the lagging and timber were left between the concrete and rock, openings for concrete were left directly back of the wall plates and end pieces to the solid rock. Thus in all cases the concrete extended from the steel set to the rock. A 6 in. x 8 in. block 12 in. long was laid in the concrete midway between the 8 ft. sets to serve as a support to the two end guides.

Concreting during sinking required two shifts to make a plank bottom and fill between three adjacent sets, or 16 ft.

The speed of final concreting was from 35 to 48 ft. per day.

Expansion and Contraction of Concrete Due to Moisture

Strength considerations have been uppermost in studies of concrete. Other properties are important, however, to explain the behavior of the material and to forecast its durability under given conditions.

Aside from the action of direct load, deformations are produced in concrete by changes in temperature and moist content. Concrete of any mix, it is generally known, has about the same coefficient of expansion as steel, so that these materials act together under the influence of temperature change. Moisture, however, affects concrete only in this respect. It expands when absorbing moisture in the same manner as many other materials expand when wetted. Steel is not subject to this action. After the concrete is poured, the steel remains unchanged with changes in moisture conditions, while concrete ordinarily shrinks to a considerable extent as it dries. Aside from the stresses set up in the steel and concrete by this shrinkage, the resulting formation of cracks, large or small, will produce a condition which may be favorable to the corrosion of the steel or the disintegration of the concrete after repeated changes from dry to wet condition.

Tests have been made at the Engineering Experiment Station of the University of Illinois to investigate the amount of shrinkage which may be expected in a mortar or concrete, the difference in shrinkage of plain and reinforced concrete and the internal stresses set up in the latter. The tests were made by Torata Matsumoto and are incorporated in Bulletin No. 126 of the Station.

The results of the tests indicated that concrete of a 1:2:4 mix is likely to contract during hardening as much as 0.05%, or about 1 in. in 166 ft., in any ordinary structure.

The stresses in the concrete caused by this decrease in volume are not as small as is generally supposed. The stress set up in the steel may reach the usually accepted working stress of steel when the amount of reinforcement is less than 1.5 per cent. In 1:2:4 concrete the stress may reach the ultimate tensile strength of concrete when the amount of reinforcement is greater than 1.5 per cent. With richer mixtures the increase in shrinkage stress may be relatively greater than the increase in ultimate strength. The greater the percentage of reinforcement the greater the tensile stress that may develop in the concrete, and concrete having a higher percentage of reinforcement than 1.5 per cent is likely to have cracks formed unless proper provision is made.

The investigation seems to indicate that reinforced concrete does not appear likely to be a durable material in a place where there is a corrosive influence on steel, such as sea air, unless proper protection against the formation of shrinkage cracks is made. The prevention of shrinkage stress and its results can be accomplished only by producing a thoroughly waterproof job.

Small Units in House Building

Roofs for Concrete Houses —Part 5

By A. J. R. Curtis
Chicago

If one were to act logically with respect to the application of concrete to reduce fire hazard and maintenance costs, I presume he would think first of applying it to the roof rather than to the walls and floors. Over and over again the reports of the National Board of Fire Underwriters have shown that inflammable roofs are the cause of a very large proportion of dwelling fires. In dwelling house fires alone, something like $15,000,000 damage is done each year by fires due directly to inflammable roofs.

No one can afford to build any kind of a house today without putting on a fire-resistant roof, for such a roof adds but little to first cost and always improves the appearance. Three types of concrete roofs are available for concrete dwellings: (1) flat or inclined reinforced concrete slabs usually supported by a system of beams; (2) concrete roofing tile laid on a wooden frame the under side of which is often covered with metal lath and portland cement stucco; (3) asbestos cement shingles on wooden framing, with the under side preferably covered with metal lath and stucco.

Flat Slab Roofs

The flat slab roof, of reinforced concrete, is laid in a manner identical with that used in laying concrete floors. In fact, many advocates of flat roofs for concrete houses feature the advantages of a type of roof which can be used as a floor or roof garden in fair weather and there is no question about the flat slab roof being a good roof wherever architecturally acceptable.

In level, treeless places groups of flat-roofed houses are usually monotonous and, therefore, to be avoided, although an occasional flat-roofed house in the midst of structures with pitched roofs is likely to prove interesting. In hilly or wooded locations particularly where the streets are winding or run up and down steep grades, groups of flat-roofs are frequently acceptable and occasionally can be made to possess great charm. Given a mountain for a background and some terraces or woodlands to work with, flat roofs, the handiest type to build of reinforced concrete, can be designed with great success.

A recent noteworthy group of concrete houses having practically flat concrete roofs are located at Phillipsburg, N. J., on the industrial dwelling site of the Ingersoll-Rand Co. These roofs consist of 3½-in. reinforced slabs with beam support. They are given pitch ample to run off water. To provide insulation and a level ceiling, the plaster and lath were supported on wooden joists. An accompanying illustration gives a sectional detail of the roofs and the method of attachment to the walls. Since the spans encountered in ordinary residence construction are nearly always short (in this case 9 ft. 8 in. was the greatest span) the design and construction of these roof slabs in place are relatively simple and within the possibilities of most good residence builders. Such slabs weigh in the vicinity of 38 to 45 lbs. to the square foot.

Concrete Roofing Tile

Concrete roofing tile is one of the most popular materials used for the covering of small houses at the present time, and recent developments in manufacturing equipment are now destined to give concrete tile leader-

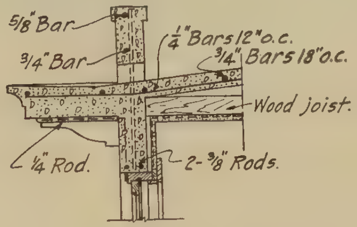


Fig. 52—Design of Concrete Slab Roof on Concrete Dwellings Built by the Ingersoll-Rand Co., Phillipsburg, N. J.

Fig. 53—Concrete Flat Slab Roofs Must be Protected Against Wind and Sun for Several Days After Laying. A Covering of Sand or Gravel, as Shown, is Often Used, Being Kept Moist for the First Week

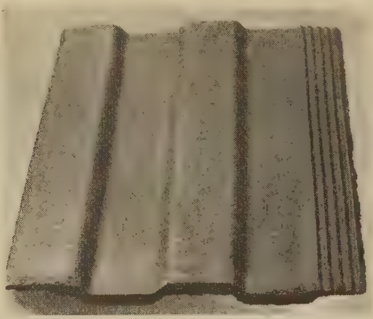


Fig. 54—Typical Flat Type Concrete Roofing Tile, Commonly Made in Natural Gray, Oxidized Green and Red. Notice the Interlocking Grooves. An Exclusive Feature with Concrete Tile Which Makes Them Weather-Tight

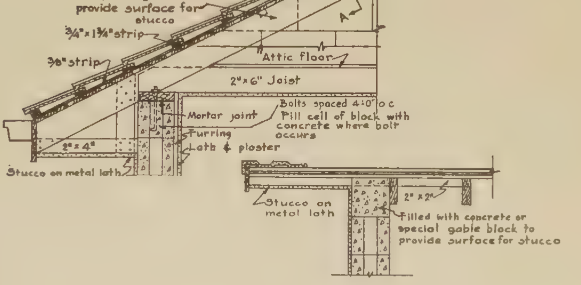

A
Concrete roofing tile
Filled with concrete or special gable block to provide surface for stucco
3/4" x 1 3/4" strip
3/8" strip
A
Attic floor
2" x 6" Joist
Bolts spaced 4'-0" o c
Fill cell of block with concrete where bolt occurs
Mortar joint
Furring
Lath & plaster
2" x 4"
Stucco on metal lath
2" x 2"
Stucco on metal lath
Filled with concrete or special gable block to provide surface for stucco
Section A-A

Fig. 55—Standard Detail for Concrete Block House with Roof of Concrete Roofing Tile. Cleveland Has 2,000 Roofs of This Material, Evidence of Satisfaction

ship in the roofing field before many seasons have passed. Houses identical in other respects have sold for $500 to $2,000 more when covered with concrete roofing tile, evidence enough of the superiority of this material. Both hand and automatic equipment for producing concrete roofing tile are fairly well known to most concrete products manufacturers, but only a relative few have realized the possibilities of the roofing business. Until the public is ready to demand all-concrete, absolutely fire-proof houses, what could be more logical from a layman's point of view than to protect the most vulnerable portion of his building with a concrete roof of a type which may be placed on almost any kind of structure?

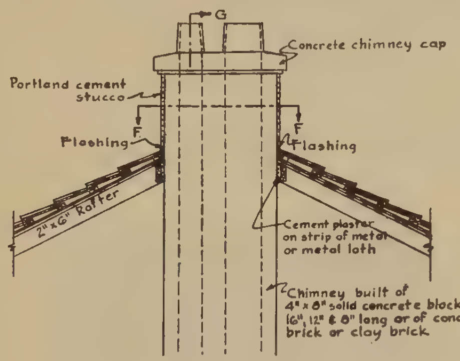

G
Concrete chimney cap
Portland cement stucco
F
F
Flashing
Flashing
2" x 6" Rafter
Cement plaster on strip of metal or metal lath
Chimney built of 4" x 8" solid concrete block 16", 12" & 8" long or of concrete-brick or clay brick

Fig. 56—Standard Detail for Roof of Concrete Roofing Tile, Around a Chimney

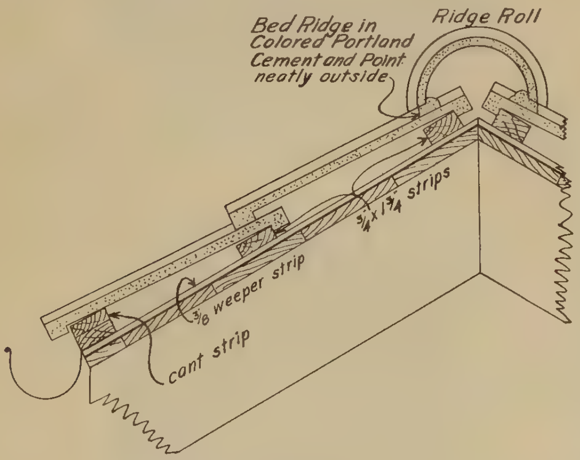

Bed Ridge in Colored Portland Cement and Point neatly outside
Ridge Roll
3/4 x 1 3/4 strips
3/8 weeper strip
cant strip

Fig. 57—Standard Method of Handling the Ridge in Concrete Tile Roof Construction

The home building contractor interested in a superior fire-resistant roofing material finds concrete tile available in almost every community. They are usually produced in three or four colors—natural gray, chrome green, red, brown, and slate. The standard tile is 9 3/16 in. by 14¾ in. outside measurements, and weighs about 5 lbs. These tile run 150 to the square, weighing about 825 lbs. Considerable less lap is required than for clay roofing tile, since the concrete product has no warpage. The accurate plane surfaces make it easy to lay concrete tile so they will be weather-tight under all conditions.

One of the decided advantages claimed for concrete tile roofs is that expansion and contraction are well cared for in the joints and, therefore, the units will not be subject to cracking. All movements of the roof or the roof frame are perfectly taken care of by these small frequent joints, a fact that makes concrete tile adaptable to re-roofing opportunities, on almost any kind of frame.

The rafter spacing for concrete tile roof should be not less than 2 by 6 in., members not over 20 in. center

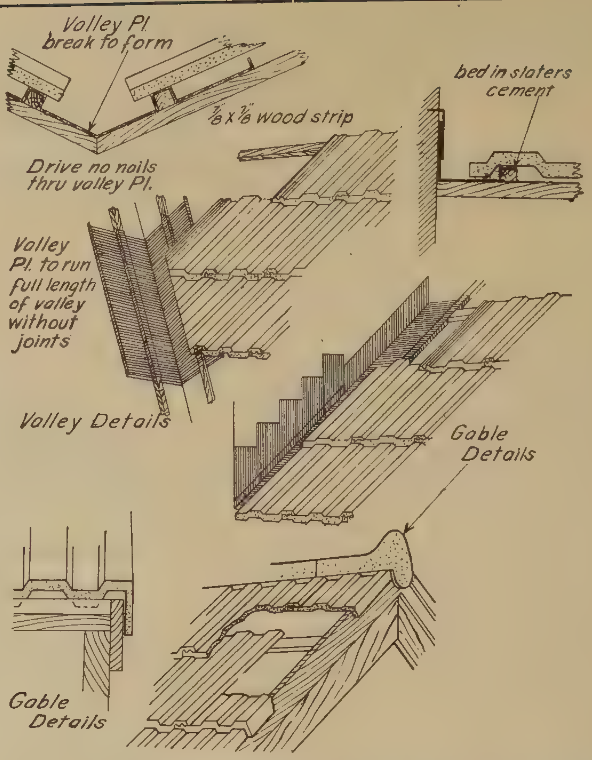


Fig. 58—Valley and Gable Details for Concrete Tile Roof Construction. Perfect Gables and Valleys are Not Only Possible But the Usual State of Affairs Where Concrete Tile Are Used Due to Their Regularity of Shape

Fig. 59—Concrete Roofing Tile is a Good Material on Houses Built of Any Material. Every Concrete Tile Roofer Takes Pride in His Perfect Jobs of Laying Straight Valleys and Absence of Complaints and Repairs

Fig. 60—Concrete Roofing Tile May be Laid Right over Asphaltic and Wood Shingle Roofs, if the Framing is Reasonably Heavy

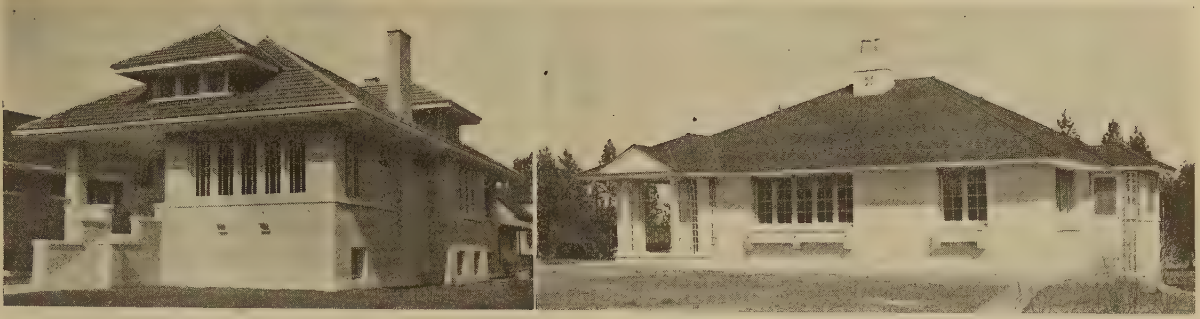


Fig. 61—Two Fine Little Concrete Houses Contrasted. The House at the Left Has a Heavy Roof of Concrete Tile, While That at the Right is Covered with Shingles. The Substantial Type of Roof Sets off the Average Small Residence to Much Better Advantage

to center. A little heavier rafter or closer spacing simply reduces the possibility of sagging or other movement. The roof sheathing is ordinarily ship lapped, closely and carefully laid. In order to finish off the ends properly, barge rafters are set so that the top edge is sufficiently above roof sheathing, and about flush with the top of the nailing strips. As in other roofs of this type, all metal work, flashing and connections must be made before the tile are laid.

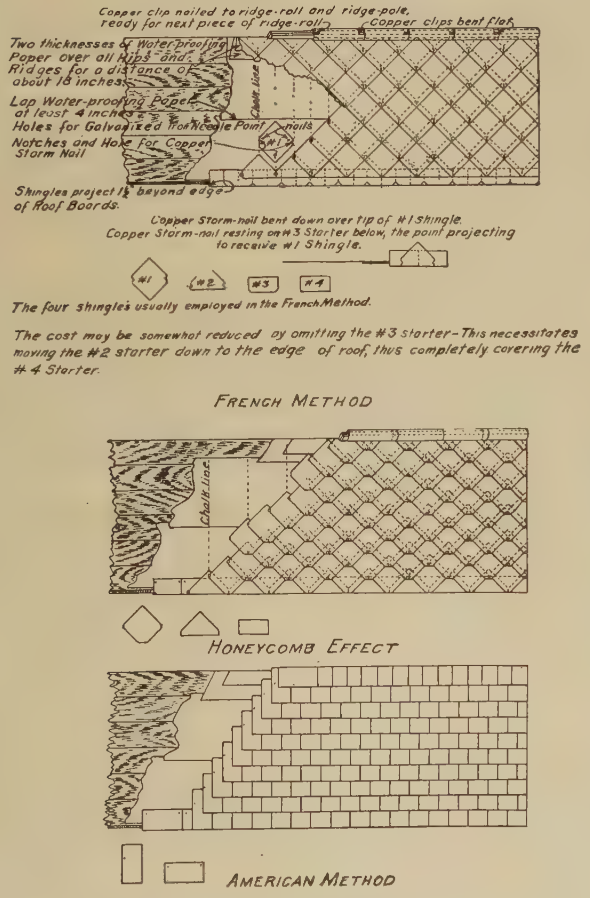

Copper clip nailed to ridge-roll and ridge-pole, ready for next piece of ridge-roll
Copper clips bent flat
Two thicknesses of Water-proofing Paper over all Hips and Ridges for a distance of about 18 inches.
Lap Water-proofing Paper at least 4 inches
Holes for Galvanized Iron Needle Point nails
Notches and Hole for Copper Storm Nail
Chalk line
#1
Shingles project 1½" beyond edge of Roof Boards.
Copper Storm-nail bent down over tip of #1 Shingle.
Copper Storm-nail resting on #3 Starter below, the point projecting to receive #1 Shingle.
#1
#2
#3
#4
The four shingles usually employed in the French Method.
The cost may be somewhat reduced by omitting the #3 starter—This necessitates moving the #2 starter down to the edge of roof, thus completely covering the #4 Starter.
FRENCH METHOD
Chalk line
HONEYCOMB EFFECT
AMERICAN METHOD

Fig. 63—Common Methods of Laying Asbestos-Cement Shingles. The American Method, Using Several Shades of Shingles Indiscriminately, Is the Preferred Way to Handle This Excellent Material

Asbestos-Cement Shingles

Asbestos-cement shingles made of a mixture of portland cement and asbestos fibre, roughly 75 per cent of the former and 25 per cent of the latter, are usually known to the trade as "asbestos shingles." They are market generally throughout the country.

These shingles have many advantages over wood, slate and asphaltic shingles. They are absolutely weather-resistant, will not curl or warp, and are very tough. The thickness is about 3/16 in. Although nailed to the sheathing, no ordinary movement of the frame can cause loosening or breakage, a common cause of annoyance with slate. The variety of colors in which these shingles are produced—gray, red, slate, blue, green and other soft shades—makes them most attractive and suitable for use where either a single color or a conglomerate mixture is desired.

The methods of applying these shingles are practically identical with those used in placing wood shingles and similar to slate. Nail holes are punched in the shingles at the factory. Both French and American systems of laying have been used extensively, but the latter is considered much more artistic than the former. Both methods are shown in accompanying illustrations. The French method is considerably less expensive of material and labor than the American method, the former covering weighing about 275 lbs. to the square, the latter weighing about 430 lbs. to the square.

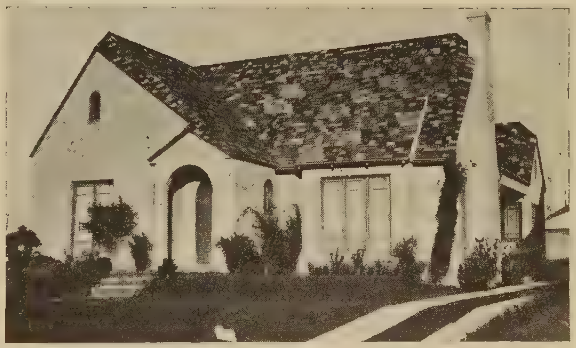


Fig. 62—Where the Architecture Calls for Light Roofs Vari-colored Asbestos-Cement Shingles are Particularly Appropriate and Form Pleasing Contrasts with Plain Stuccoed Surfaces

Since both the concrete roofing tile and asbestos-cement shingles are ordinarily applied to roof frames of ordinary wooden construction, means should be taken to protect these frames against fire. All surface under and about the eaves, not covered by the roofing, should be covered with metal lath and portland cement stucco. The under side of the roof on the interior should be similarly covered with metal lath and cement plaster.

The Trial of Eastern Cement Manufacturers

(Continued from Page 190)

tives of the Government at various stages of the organization, and to investigations by Government officials at various dates prior to the present proceeding. At the very outset of the C. M. P. A. the proposed organization seems to have been described and discussed by its counsel with officials at Washington. Somewhat later the record contains a long letter Alfred Thom, of the Federated Trade Commission, dated late in 1917, in which operations are described in detail.

At a C. M. P. A. meeting held in July, 1919, the main point of interest in the minutes seems to be a statement by its Vice-President: "The members will probably be interested to learn that this office was visited on Tuesday, July 8th, by Mr. Henry S. Mitchell, of the Department of Justice, who stated that he had been commissioned to investigate the cement industry and particularly the operations of this Association. We furnished Mr. Mitchell with all of the data that he called for, lists of our reports, examples and samples of our work, and I answered as best I could such questions as he asked me. With the permission of the members of the Association I will continue to assist him in every possible way in the investigation that he has undertaken." Replying to a question by a member, the Vice-President said further: "It is a fact that since the organization of this association we have furnished continuously samples of all reports and minutes of all meetings to the Federal Trade Commission. We furnish a sample of daily reports, and a copy of each monthly report with such other reports as we made to the Federal Trade Commission. I called that to Mr. Mitchell's attention, but it seems that the departments in Washington do not co-ordinate, and he asked that we send such reports as he wanted direct to him at Washington, which we did."

From the Dealer's Standpont

It is worth noting that the testimony so far presented by the Government does not seem to bear very seriously or very directly upon the interests of the ultimate consumer of cement, but rather upon the interests of the dealer in cement. During the first three weeks of the trial nine dealers and two salesmen were placed on the stand by the Government, and practically all the testimony elicited from them, on either direct or cross-examination, dealt with matters of trade practice as between cement manufacturer and cement dealer.

The witnesses who testified regarding trade practices were Messrs. George Howard Elliott, vice-president in charge of sales of Whitehall Cement Co.; Arthur J. Whipple, formerly sales manager in the New York City region for Atlas; Luther Keller, of the Luther Keller Co., dealers in Scranton, Pa.; Eurie L. Merriman, also a Scranton dealer; Bert H. Hanby, secretary of the Batavia Lumber & Coal Co. of Batavia, N. Y.; Edward M. Rodrock, dealer, of Paterson, N. J.; Allen P. Lockwood, formerly salesman for Hercules, and now a dealer in Buffalo, N. Y.; Harry W. Gilbert, of Germantown, Pa.; Joseph H. Clark, of Philadelphia; John H. Kelter, also of Philadelphia; Alfred L. Lyth, of the A. L. Lyth & Sons Co., Buffalo, N. Y.

Each of the eleven witnesses of the group above named was a man who has had long experience in cement dealing or cement selling, or both; the testimony of each of them conveyed an impression of frankness and an obvious effort to answer carefully and exactly every question asked him, either on direct or cross-examination. The result is a mass of detailed answers covering some 500 printed pages. Yet with all this detail available, contributed by able men, the net result seems to me to be somewhat confusing and inconclusive. That impression, gained while listening to the testimony, is only intensified as I read over the printed records. The impression created by the Government on direct examination was more or less completely neutralized by exceptions or limitations which the same witness would make during the cross-examination.

The manner in which this was brought about appears if we summarize the methods of the prosecution and the defense in treating this dealer testimony. On the one hand Mr. Fowler, examining directly for the Government, asked of practically all the witnesses questions which may be stated about as follows:

1. Have cement prices been substantially uniform at any given time since 1916, as between the different defendant companies?
2. Do the different companies give the same discounts?
3. Are allowances for returned bags uniform?
4. Are contract forms similar?
5. Is there then any difference whatever between different cements offered you which would benefit you in choosing one rather than the other.
6. What has been your experience with C. M. P. A. checkers?

To these questions practically all of the witnesses replied that prices, discounts, bag allowances and contract forms had been similar; that there was no reason for choice as between brands; some said they had no experience with checkers, others told of having checkers visit their office or their jobs to secure data on contracts, in several instances witnesses stated that they had refused to give information to checkers, on the ground that "it was none of their business."

On the cross-examination Colonel Stimson, for the defense asked each witness questions which cannot be summarized so readily, but which resulted in almost general replies to the following effect:

1. There have been times since 1916 when there were differences in prices as between the defendant companies. The cement scarcity during 1920 was due to car shortage and coal shortage.
2. Discount allowances are similar in other lines of building material that I handle.
3. Bag allowances have nothing to do with prices, since the allowance merely covers a charge originally made for the bag.
4. In one or two cases there are slight differences in contract forms.
5. Since all cement is now sold subject to standard tests, there is no reason why one brand should be worth a cent more than another.
6. The dealers who had refused information had never heard anything more about the matter, and their business had not suffered from their refusal.

It will be seen that the replies on cross-examination did not always exactly nullify the testimony given on direct, but they tended in that direction.

The Portland Cement Association

William M. Kinney, secretary and general manager of the Portland Cement Association, was on the stand April 21 and 24. His direct examination by Mr. Fowler for the Government was relatively slight, and was used as a medium for establishing the fact that for some years in the past the P. C. A. received reports on output from its members. The witness was then turned over to the defense, which took him up as their witness. Mr. Fowler announced that he would reserve the right to cross-examine Mr. Kinney later.

In his examination by Mr. Dorr, for the defense, Kinney was taken over the whole story of the technical, educational and promotional activities of the P. C. A. He testified that 320 employees were working for the Association; that it had member companies not only in the United States, but in Canada, Argentina and Mexico; that it had some 30 branch offices in various large cities all in the United States except one at Vancouver, British Columbia.

Bulletins and other literature prepared and distributed by the P. C. A. were exhibited and examined by the jury which seemed interested. A large chart, showing cement output over the last six years vs. sand, lime, sand-lime brick, sandstone, slate, face brick, common brick, vitrified brick, granite, etc., was shown. It was pointed out that although all these building materials had suffered in output because of war conditions and post-war troubles, cement had shown the least loss of all at any time, and over the six-year period had shown an actual slight gain as compared with very heavy losses for brick, sandstone and granite.

After taking testimony regarding the operations of the Portland Cement Association from Mr. Kinney, its secretary and general manager, the Government placed on the stand a number of contractors and public officials interested in the consumption and use of portland cement in one way or another. Mr. Kinney's testimony had brought out very clearly the fact that the main activities of the Portland Cement Association are educational, designed to secure both a wider and a more intelligent use of portland cement; and that it had never been interested in any way in questions of cement prices, rates, etc. The testimony of the various consumers was evidently designed to fill up the gap in the Government line of evidence, and to bring out, if possible, some complaints by users of cement.

Along this line the evidence of contractors and public officials was, however, even less conclusive than had been that offered by the dealers in previous sessions. The contractors represented were important concerns—such as the Foundation Company, the Fuller, and Thompson-Starrett companies. The officials represented the Boston Transit Commission and the New Jersey Highway Commission. In all cases the Government brought out the fact that in the New York district all these consumers had purchased through dealers and not direct from the mills. But, equally in all cases, the witnesses added that they did this by preference, so as to secure the advantages of storage, trucking, and longer credits. It was held, in this connection, that dealer prices were not pertinent to the issue in the present case.

The Closing of the Government Case

In the last days of April the Government was preparing to close its direct case. In doing this statistical exhibits were to a large extent the basis of the oral testimony, and it is very difficult to summarize fairly eighty or more detailed sheets of figures within the limits available.

The first of these closing witnesses was Charles D. Tedrow, division rate clerk of the Interstate Commerce Commission. Mr. Tedrow produced and filed as Government exhibits 55 freight tariffs covering the month of October, 1918, on almost all of the roads operating in the Lehigh district and adjoining territory. These are placed in evidence by the Government in support of its claim that the freight rate books issued by the Cement Manufacturers Protective Association were based upon incorrect and arbitrary rates. But as any proof or disproof of this claim manifestly involves comparison of some tens of thousands of individual rates, it is questionable if the introduction of these rates *en masse* does not merely tend to confuse the issue. It is probable that the difficulty will be solved by selection, under stipulation by the opposing attorneys, of a few specific rates; and of argument on these particular cases.

The second witness of this type was James W. Allen, auditing accountant in Government employ. Mr. Allen introduced 31 massive tables of statistics and deductions therefrom. These exhibits, when piled up, make a stack over a foot high. But their titles give a very fair idea of what the Government hopes to prove from them—an allocation of business as between the different defendant companies.

The Cement Trial will probably end in time to present a complete summary in CONCRETE for June.

American Engineering Standards

The American Engineering Standards Committee is endeavoring to serve as a national clearing house for engineering and industrial standardization, as the official channel of co-operation in international standardization and to provide an information service on these matters. The membership of the Committee is composed of representatives appointed from five departments of the Federal Government, nine national engineering societies and fourteen national industrial organizations. The ultimate responsibility for and control of the work rests with these bodies. The work of the committee consists in bringing about systematic co-operation of the organized bodies which speak for industry. The work of the committee is supported by the dues of the member bodies.

This Committee is not an initiating body and work on a project is undertaken only upon a formal request from a responsible body, and then only after the Committee has assured itself that it is the desire of the industry that the work should go forward. A formal conference of the bodies concerned with the proposed project is called and asked to decide what the scope of the work shall be, how it shall be organized, and how it is related to any other work having an important bearing on it. The organizations attending this meeting are called "sponsors." What is known as a "sectional committee" is then formed, under the guidance of the sponsors, from accredited representatives of the various organizations, which speak for the branches of industry concerned in the formulation of the particular standard under consideration, as well as one or two outstanding specialists of no particular connection. The personnel of this committee must be approved by the Main Committee. After approval of the standard by the Main Committee, it is published.

At present there are 170 bodies co-operating with the Committee in work on 79 various projects. Besides this work, the Committee maintains an information service on all existing standards, over 2,000 being listed. It also co-operates with similar organizations in other countries for the formulation of international standards.

Concrete in Front Line Work, 1914-1917

(Continued from Page 200)

"By all means it is necessary to make shelters which shall be capable of resisting a sustained fire from 15 cm. pieces; in addition, it is desirable, particularly in the rear lines, to build shelters which are proof against a sustained fire from pieces of 22 cm. calibre and from the lucky hits of even larger calibres."

The instructions add that both these degrees of protection can be secured, either by tunneled dugouts or by concrete structures; and they point out the advantages of the latter in permitting rapid exit of the personnel.

As to details, the new instructions tend toward a far better concrete, for one thing. In place of the weaker mixtures recommended in 1915, the 1916 orders specify a 1:2:4 mixture even for plain concrete, and they seem to have suggested an even richer mixture for reinforced work. The difficulty of securing a good contact between reinforcing and concrete is emphasized, and it is suggested that a somewhat wetter mix be used for reinforced than for plain concrete. There is also a closer limit on sizes of stone or gravel.

The points so far mentioned were kept as standard German practice up to the end of the war; but on several other points there was still to be experiment and progress. One of these involved the use of concrete blocks; that was tried by all the armies as a means of avoiding concrete-making in the trenches. It was a paper success and a practical failure; for shelters built of blocks, even when held together by wire or rods, did not stand up against shell-fire.

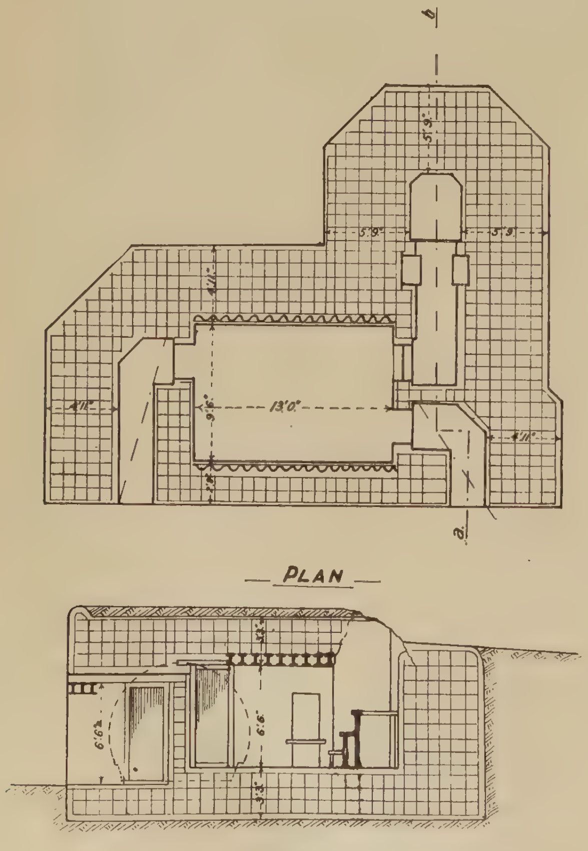


FIG. 9—GERMAN SHELTER WITH OBSERVATION POST, SHOWING UNIFORM REINFORCING

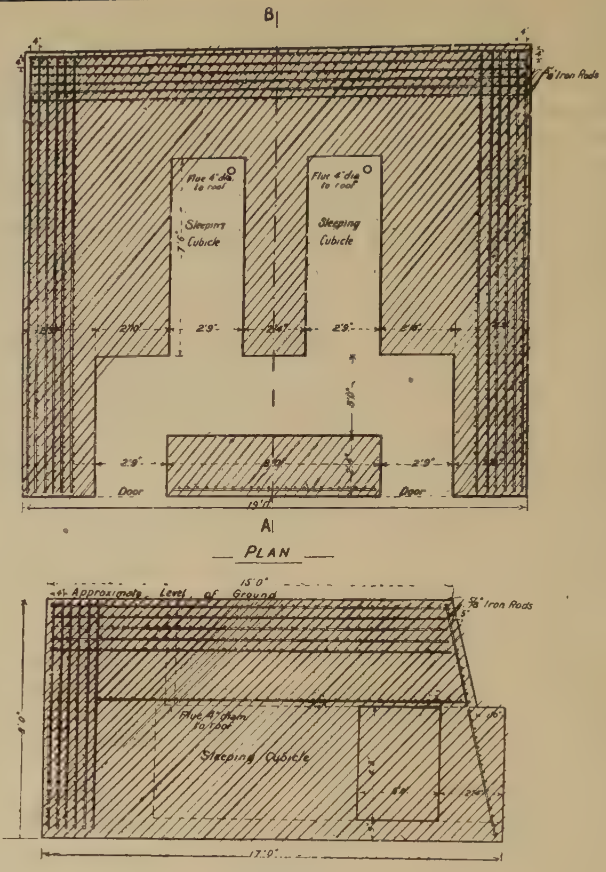


FIG. 10—GERMAN SHELTER, LATE TYPE, SHOWING SURFACE REINFORCING ONLY

The 1916 instructions still permit the use of intercalated beds or layers of rails, but in actual practice this seems to have been soon set aside definitely. Experience showed that their use introduced easy slipping upper concrete mass off the bed of rails or beams.

On still another point there was progress during 1917. This was in regard to the disposition of the reinforcing. In all the earlier work the rods had been distributed practically uniformly throughout the mass of concrete. The typical German shelters of late 1916 show this practically uniform spacing, vertical and horizontal, of the rods, as is shown in the example in Fig. 9. The experiences at Verdun had probably raised doubts as to the economy and necessity for such uniformity, and later experience seems to have confirmed these doubts. At any rate, from the early spring of 1917 on to the very end of the war the tendency seems to have been toward abandoning uniform placing in favor of concentrating the reinforcement near the two surfaces of the roof or wall. In good examples of this later type, which are still visible in great numbers in the Warneton-Perenches region, the commonest method of reinforcement is to leave the body of the wall of plain concrete, to place two grills of reinforcing parallel to and near the exposed surface, and a third grill, or a sheet, on or near the inner surface, so as to guard against fragments falling in the interior. This general type is well illustrated in Fig. 10, copied from a drawing by the Australian engineers of a shelter found during the Messines attack in 1917.

V.—TECHNICAL SUMMARY

In the preceding, the development of concrete fortifications during the World War has been treated in chronologic order, so as to get some idea of the stages through which it passed, and the direction in which it was trending until its normal progress was checked by planes, so that a direct hit often resulted in sliding the the events of 1918. In 1918 the normal sequence was interrupted, because the Allies discovered a new source of man power, and because the Germans had to try for a decision before this new supply of men could be put into the balance. So in 1918, with a supply of fresh troops, there was a return to the old open warfare. It will be noted that I am frankly stating an entirely heretical theory, in that I look upon position warfare as likely to be common in future and open warfare as likely to be uncommon. Some of the main technical features of this development may be profitably summarized before closing the discussion.

Kinds of Cement Employed

Throughout the entire war the British and the Germans used only artificial portland cement in their constructions of all kinds. The French used portland cement for most of their work, but they permitted and even advised the use of slag cement for temporary works. In the arch footings and foundations of all the permanent fortresses (Verdun, Belfort, etc.) they had always used hydraulic lime. The American regulations on the subject took a very clear and definite stand in the matter, ordering that no other cement than portland be used for front line or other important works.

From early in 1915 on through 1917 both Germans and French used specially rapid-hardening elements for heavy-gun mounts. These special cements were essentially very high alumina portlands, which set normally but attained in 12 hours a strength not reached by ordinary portlands in a month or more. Elsewhere[2] I have described the French cement which was used for this purpose and it does not need further discussion here.

Proportions of Mixtures

Throughout the war the French concretes were made with mixtures higher in stone than were the German or British. This was in part an economic necessity, owing to the scarcity of cement in France; but it was in part also a heritage from the teachings of the Army Engineer schools before the war. In all of the great permanent works that had been built or modified between 1888 and 1914 the proportions described were as follows, varying according to the exposure of the structure, to make a cubic metre of finished concrete.

Proportions	Subject to direct hits	Subject to occasional hits	Entirely Sheltered
Stone, cubic metres	0.90	0.90	0.90
Sand, cubic metres	0.30	0.30	0.30
Stone, cubic metres	0.90	0.90	0.90

During the war the 300 and 400 kg. mixtures were those specified and used by French army engineers in all fortifications, whether temporary or permanent. The method of stating the cement in kilograms and the other ingredients in cubic metres should not make us overlook the fact that all these mixtures are low in mortar and high in stone. They were originally worked out at the schools many years ago from Feret's experiments; and the ratio between stone and sand is one that can be attained in the laboratory, under absolutely perfect mixing, and with theoretically perfect sizing of both sand and stone. In actual practice such a mixture is apt to leave voids; and at its very best there is no surplus whatever of mortar. So, though the 400 kg. mix contains enough cement, it is a rather lean mix in its mortar-stone ratio. As for the 150 and 200 kg. mixtures, these correspond roughly to ratios of 1:4:12 and 1:3:9.

As against this we have the German practice, which ran toward a better-balanced concrete. At its worst, in early 1915, the German proportions allowable in plain mass concrete were 1 cement, 3 sand, 6 stone. On the average, 1 cement, 2 sand and 5 stone was the common mix for plain concrete. After the first few months of experience, the German instructions placed the proportions for plain concrete at 1 cement, 2 sand, 4 stone. For reinforced work the same proportions seem to have been kept in practice, though there is a suggestion, perhaps merely a pious hope, that a 1:2:2 mix could be used to advantage. None of the later German concrete work in Belgium or western France, however, gave any 1:2:2 result when actually tested—a method of investigation which was still possible at a very large number of points as late as the Spring of 1919.

For concrete mixed under field conditions, with sand, stone and gravel coming from pits and quarries, and not from laboratory screens, the difference between $1:1\frac{1}{2}:4\frac{1}{2}$ and 1:2:4 is the difference between a doubtful and a sound mixture. And I think that any one who has compared the conditions of the French permanent works at Verdun and Maubeuge with that of the German field works along the British front, will agree that it does not pay to use too much stone.

Character of Reinforcing

At the outset reinforcing was frankly an afterthought. All the early work was done by the infantry alone, and had to be very simple. At first steel was used simply as a support for the concrete mass, not as a proper reinforcing. Rails, sleepers, steel ties and beams were available; and these were used as a base. Occasionally a thin second layer of such material was placed somewhere in the concrete mass; and then nails, wire and scrap of various sorts were thrown in casually by enterprising experimenters.

By the end of 1915 both French and Germans had begun to take the matter seriously, and from then on we find definite specifications. And we also find the employment of special troops, who knew something about the use of cement, and could be trusted or trained to use reinforcing intelligently.

At its highest point, before Verdun, reinforcing seemed to have reached a fairly standardized character. It was of round rods, $\frac{3}{8}$ to $\frac{5}{8}$ in. diameter, uniformly spaced throughout the mass of the concrete, with series running both vertically and horizontally. To this primary reinforcing was added, in most cases, a close grid located near the exterior exposed surface and parallel to it. And, on the interior, there was commonly a layer of expanded metal to stop the fall of fragments. The weight of steel per cubic yard was standardizing around 130 lbs., all the reinforcing elements included, though some designs fell as low as 90 lbs. per cubic yard.

After Verdun methods again diverged, as has been stated in detail earlier. The French tended toward use of heavier masses of plain concrete for permanent works, and toward minimizing the use of concrete in temporary works. The Germans improved the grade of the concrete used, tried and abandoned several methods of reinforcing, and ended by using reinforcement chiefly concentrated near the two surfaces of the mass.

Until quite late in 1917, when the final collapse of Russian resistance made it possible to think of taking the offensive on the Western Front, the Germans were using more and more concrete every month. Given similar conditions as to troops and terrain, it seems at least possible that future great wars will develop along the same line

Hillman System of Hollow Walls

Monolithic, hollow wall houses are being constructed in Los Angeles by the Hillman system in competition with frame construction. Hillman system walls are built with forms consisting of steel plates 24 in. high and of varying lengths. Four plates of equal length constitute a form unit for pouring a hollow wall.

In practice the forms are raised on standards of 1½ in. galvanized pipe, which are set up on the foundation between the walls, to be constructed and removed when the walls are completed.

There are two standards for each set of forms. They are plumbed, braced in alignment and held in position by a 2 x 6 timber at the top. The forms are suspended from arms which project laterally from opposite sides of a sleeve mounted on the standard, and are adjusted to various wall thicknesses by means of bolts. The forms overlap the walls 2 in. at each course, and are held together during the pouring by set screws threaded through projecting arms at the top of the outer plates, and pushing against similar projections on the inner plates. The resulting pressure clamps the bottom of the forms solidly against the top of the last course of the wall. After the course has been poured and is hard, the forms are released by loosening the set screws, and are then elevated and held by two clamping bearings on each standard. The holding clamp rests around the standard above the sleeve, and is connected by a chain to the bottom of the sleeve. The weight of the forms upon the sleeve causes the holding clamp to bind on the standard, thus holding the form in position. The lifting clamp bears upon the standard directly above the holding clamp, a lever being pivoted to the lifting clamp and linked to a lug at the lower end of the sleeve. The downward movement of the lever causes the lifting clamp to slide upward on the standard and bind on it at the end of the stroke. An upward movement of the lever then elevates the sleeve and the holding clamp, which in turn binds upon the standard when the lever is released. This operation is repeated until the forms have been raised for the next course.

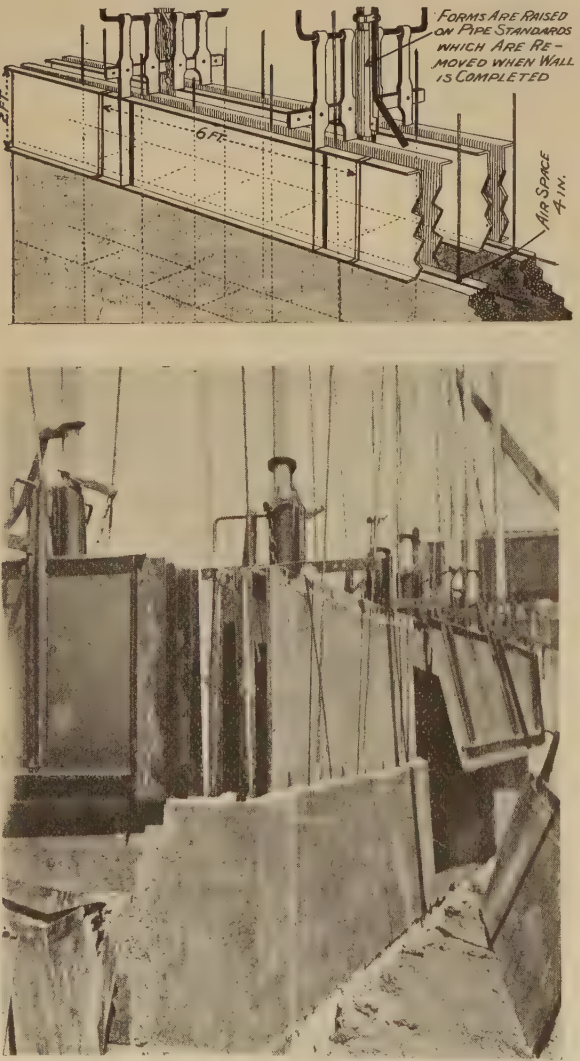

Forms Are Raised on Pipe Standards which Are Removed when Wall is Completed
2 Ft.
6 Ft.
Air Space 4 in.

Fig. 1—Details of Hillman System

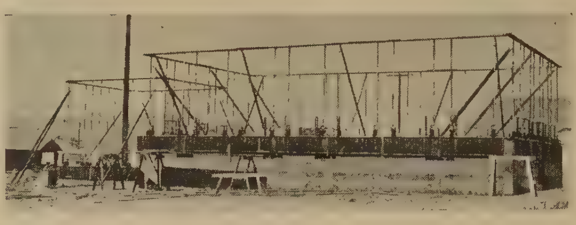


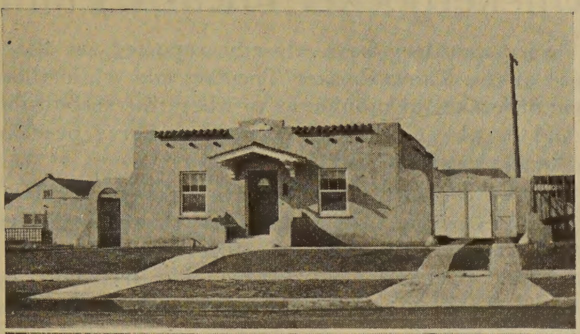
Fig. 2—Standards Erected and Pouring Begun with Hillman System

The form plates are made of 12 gauge steel, rolled at the top, reinforced at the bottom with 1¼-in. angle iron, and stiffened at the sides with two vertical, U-channel arms pressed out of 3/16-in. steel. These plates are made in 4, 5, and 6 ft. lengths, 24 in. high. The inside plates are notched to receive metal cross ties, which are set in place before pouring.

An 8-in. wall is built with 2-in. slabs and a 4-in. air space, the 10-in. wall with 3-in. slabs, and a 4-in. air space. The forms are adjustable for thicker walls. When the standards are set plumb no further adjustment of the equipment is necessary to insure a plumb wall. The lap joints make the wall continuously smooth and obviate leakage through the bottom of the forms. The corners are built with sets of four right angle forms, which are self-aligning. These are hooked at the top and bottom to the wall forms. Extension wall plates to provide for fractional measurements are attached in a like manner.

In constructing partition walls, or foundation and solid exterior walls, both forms are suspended from the same side of the standard. Sometimes, in the case of heavy solid walls, one plate is suspended from each side of the standard, which is left in the concrete. Standards are not required on walls less than 4 ft. high. In two or more story work the thickness of the walls or the thickness of the inner wall is reduced at the floor line. When desired the walls may be filled solid beneath the bearing of the floor joists. Intersecting walls and partition walls are poured one course behind the main walls, and are tied into the main walls by means of steel reinforcing.

Pegs of reinforcing steel 8 in. long tie the walls to the foundation and project from the foundation for the forms to clamp against for the first course. Vertical reinforcing steel is set on 2-in. centers in the first course and is continuous from the foundation to the required height. Horizontal steel is placed in the forms at each course and turned at the corners. Floor joists may either bear on the foundation wall, on studding built



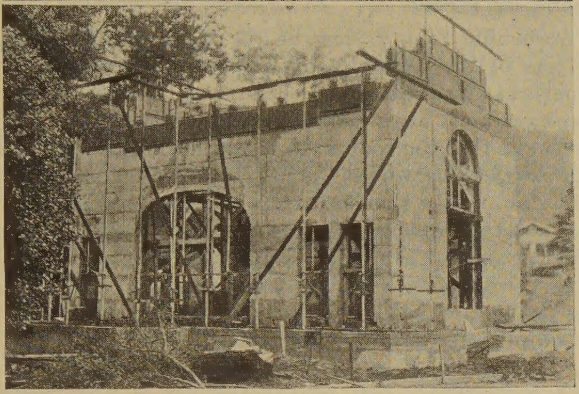


Fig. 3—Completed House by Hillman System
Fig. 4—Hillman System in Operation

out from the wall, or be received through the inner wall. Openings are framed at any point by blocking forms with rough strips lightly built up to any required size. Blocks are set in forms and built in wall for nailing permanent frames and trim. Plumbing and electrical conduits are carried in the air space.

The double exterior walls of a one-story house 28 ft. by 43 ft., and a garage 20 ft. by 20 ft., comprising a wall area of 2,456 sq. ft., are reported as being erected in October, 1921, at a cost of $419. The walls were 8 in., built up of two 2-in. slabs, with a 4-in. opening, and were reinforced with 1/4-in. square deformed bars placed vertically and horizontally on 2 ft. centers in both walls, and tied with steel ties built in the walls 1 ft. apart in every 22 in. course. The concrete was mixed in a batch mixer and placed by hand. The wall cost, averaging 17 cents per sq. ft. surface of double wall, is distributed as follows:

125 sacks cement, at $0.85	$106.25
15 yds. sand, at $2.50	37.50
15 yds. rock, at $2.75	41.25
Steel	49.00
Labor (mixing and placing)— 1 man at $8.00; 3 men at $4.00; for 7 days	140.00
Labor (setting up equipment)—4 men, 1 day	20.00
Labor (taking down equipment)—4 men, 6 hours	15.00
Frames for blocking openings	10.00
Total	$419.00

After forms were removed, the interior and exterior walls were ready for the plaster and stucco, which was put on at a less cost than would be possible with metal lath.

This is a typical example, unit costs showing but a slight variation on a number of jobs. For this job, one mechanic and three laborers were employed. The equipment was set up in one day, 2 ft. of wall poured for the first course, and a course was poured each day following. The completed walls were 13 ft. high. The equipment was taken down in five hours. For thicker walls the labor and material costs would be the only items that would increase. Concrete is indebted for the foregoing information to the Monolithic Hollow Concrete Form Corp., Los Angeles, Cal.

Bates Experimental Road Test

The road tests on the Bates Experimental Road, south of Springfield, Ill., mentioned in Concrete for December, 1921, were started March 30, 1922. The road, approximately two miles long, is made up of sections of various types of pavement, and was tested by driving trucks over it in the same line of travel, and noticing closely the progressive deterioration. Three-ton Liberty trucks were used, stripped to the chassis and cab, so that the load on each rear wheel was 2,500 lbs. and the load on the front wheel was 2,250 lbs. This corresponds to a nominal load of 250 lbs. per inch of width of rear tire, and 450 lbs. per inch of width of front tire.

The trucks made 1,000 round trips over the same path. Each edge of the pavement, therefore, was subjected to 1,000 applications of both loads. This load produced a fibre stress of from 300 to 400 lbs. per sq. in. in the material. The test specimens cast with the sections have shown a modulus of rupture of from 600 to 650 lbs. per sq. in. The actual stress was therefore from 50% to 65% of the ultimate, and is likely to be above the endurance or fatigue limit of the concrete as indicated by the laboratory fatigue tests, which showed that concrete, stressed to 60% or 70% of its modulus of rupture will fail with from 100 to 2,000 or 3,000 applications of the load.

In the case of rigid pavements, traffic breaks were considered failures when the area of the section broken free from the balance of the pavement was so small that subsequent applications of the same wheel load caused undue impact on the broken sections, as well as on the adjacent pavement. These tests confirm previous observations that such breaks are quickly followed by progressive failure of the adjacent pavement. On rigid pavements corner breaks only have occurred. Thus far no additional transverse or longitudinal cracks have appeared.

In the case of the so-called flexible surfaces, such as asphaltic concrete or bituminous filled brick on a concrete base, failures are recorded when the base becomes broken in the manner previously described.

In the case of the asphaltic concrete and bituminous filled brick sections laid on macadam base, failure is reported when a sufficiently marked disturbance of the wearing surface occurs as to indicate plainly that subsequent applications of the same load will cause complete disintegration of both the surface and the base.

On Section 10, a 2-in. Topeka asphaltic concrete wearing course on a one-course 4-in. Novaculite base course, failure was practically continuous, and complete failure along wheel tracks occurred rapidly after the pasage of about 800 loads.

Section 11, a 2-in. Topeka asphaltic concrete wearing course on a one-course 4-in. macadam base, developed three failures.

Section 23-B, a 3-in. lugless brick, with a bituminous filler, on a 1-in. sand cushion over a 6½-in. concrete base of a 1:2:3½ mix, with crushed limestone as coarse aggregate, developed three points of partial failure.

Section 33, a 3-in. brick, monolithic, on a 2-in. base course of 1:2:3½ concrete, with crushed limestone as coarse aggregate, developed initial corner breaks with a rapid progressive breaking of the adjacent pavement.

Section 35, a 4-in. brick, monolithic, with a 2-in. base course of 1:2:3½ crushed limestone concrete, developed two corner failures.

Section 36, a 3-in. brick, monolithic, with a 2-in. base course of 1:3:5 crushed limestone concrete, developed three corner failures with progressive failures starting from two corners.

Section 37, a 3-in. brick, monolithic, with a 3-in. base course of 1:2:3½ crushed limestone concrete, developed one corner failure.

Section 58, a 4-in. 1:2:3½ crushed limestone concrete slab, on a 4-in. rolled stone base course, developed two corner failures.

When corner breaks occurred and depression on the broken section followed, every reasonable effort was made to maintain a smooth surface and avoid impact.

On account of the prevalence of extraordinary rains, the testing was temporarily suspended, to be resumed with larger wheel loads. It is expected that practically all corners of the 4-in. pavements, where no dowell bars were used and where cracks are open, will be completely destroyed, as well as some of the corners of the 5-in. pavements. Somewhat less pronounced failures are expected in sections having a flexible wearing surface on bases of the thickness above mentioned.

The breaks in sections 33, 34, 35, 36 seem to indicate that the working fibre stress for monolithic and semi-monolithic brick pavements must be considerably less than for concrete pavements.

Fire Tests of Concrete Building Units

The fund that is being raised to finance the fire tests of concrete block, which will probably be conducted at the Underwriters Laboratory, Chicago, under the direction of the Committee on Fire Resistance of Concrete Building Units, of the American Concrete Institute, is about $1,000 shy. It is very important that the money be forthcoming soon in order that the test blocks may be manufactured and allowed sufficient time for curing before they are built into test walls. Detailed announcement was made last month of the contribution of the Portland Cement Association of $2,500, of the American Concrete Institute of $500, and of individuals through the Concrete Products Association, totaling $1,128 in cash and $575 in pledges. W. R. Harris, president of the association, announces that this has been increased to $1,900 cash and $237 pledged. Individual contributions to the Institute total $130, making the present cash total about $1,000 short of the estimated $6,000 needed.

Knickerbocker Theatre Failure

Two committees have already reported on the collapse of the Knickerbocker Theatre, and while there is some difference of opinion as to where the responsibility should be placed, the two committees agree practically on the cause of the failure.

The two committees which have already reported are a committee of the Washington Chapter of the American Association of Engineers and a board appointed by the Associated General Contractors. The board of engineers of the War and Navy Departments has not made public its report.

According to a review of the many weaknesses and defects of the structure given by the committee of the American Association of Engineers mentioned in the *Engineering News-Record,* no evidence was found in the wreckage that the roof slabs failed until after the failure had started elsewhere. The committee finds that the roof slab, with a working stress of 16,000 lbs. per sq. in., had a total capacity of dead and live load of only 23 lbs. per sq. ft., while the actual load was about 75 lbs. The reinforcement had a yield point of 73,000 lbs. per sq. in.

While inadequate strength of roof slab is listed among the principal defects, it is cited that a breaking of the roof slab could not have pulled the beams toward each other, since in the southeast corner of the building a large slab of the roof is still holding together unsupported, making the action suggested by one army officer appear unlikely.

Other principal defects listed by the American Association of Engineers' Committee as most deserving criticism are: support of main truss on a thin wall, lacking solidity and mass.

Support of main truss on a skew bearing, combined with lack of stiffness in the gusset between the end post and the lower chord of the truss.

Failure to anchor trusses and heavy beams into walls.

Scant bearing at walls.

Insufficient section area and inadequate details of truss members.

Inadequate column bracing.

Absence of lateral support at intermediate panels of the main truss.

Absence of diagonal bracing between other trusses.

Many defects in concrete and much difficulty are credited to coatings of clay, loam or silt on the sand particles used as aggregate. Natural gravel may be coated with a film of material which reduces the strength of the concrete unless the film is removed by washing. The film tends to separate the cement and the mixture of cement and sand from the coarser particles of aggregate, making a poor bond and consequently a concrete of inferior strength.

The length of time that should elapse before forms are removed from concrete work depends upon a number of conditions. The nature of the structure is of importance, and among the other factors may be mentioned the nature of the stress to which the member is to be subjected, the nature of the cement used, whether it produces a concrete that hardens rapidly or slowly, the temperature and humidity of the surrounding air, and the relation between the dead and live loads to which the members are subjected.

Trade Publications

Sellpin—Augustus H. Sell, 858 South 13th St., Newark, N. J. A little circular describing a specially constructed push pin with a hook on the side for holding the tape in making tape line measurements.

Hoists & Derricks Bulletin HD 501—Pawling & Harnischfeger Co., Milwaukee, Wis., 18 pp. and cover (loose leaf) 8½ by 11 in.; describing and illustrating the hoists and derricks manufactured by this company. Tables of specifications and data concerning this equipment are included.

Science and Practice of Integral Waterproofing—Truscon Laboratories, Detroit, Mich., 4 in. by 9 in., 33 pp., illustrated from line drawings and photographs. This booklet devotes the first fifteen pages to the subject, "Why Concrete Requires Waterproofing," and the peculiar properties waterproofing must possess for use in concrete. Then follow eight pages of specification for waterproofing mass concrete and general masonry by the cement plaster coat method, and for waterproofing cement stucco.

Of special interest to contractors and engineers are the final eight pages, devoted to the practical application of the waterproofed cement plaster coat.

Hahn Concrete Lumber System, 903 Majestic Bldg., Chicago —8 pages and cover with insert of details, 9 inches by 12 inches. This system has been described in detail in CONCRETE recently and the catalog serves to supply more complete information in regard to the working out of this system of precast unit construction.

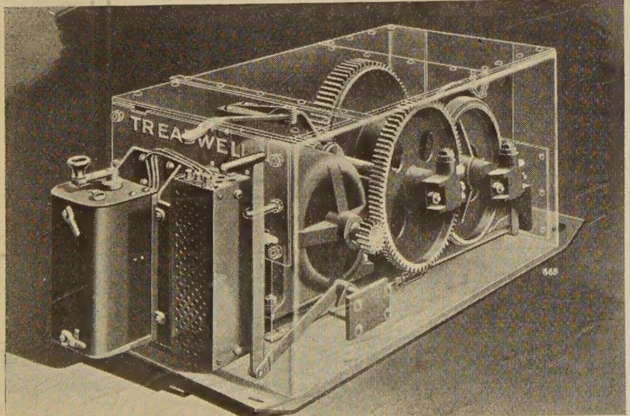
Road Making Machinery, Catalog No. 22—Stroud & Co., Omaha, Neb., 24 pp. and cover, 7½ by 10½ in., in two colors, illustrated; telling of the Stroud line of highway builders' equipment, including graders, scrapers, maintainers, carts, wagons, plows, truck bodies, bulldozers, drags, and steel bunk equipment.

Smith Paving Mixers, Bulletin 409-C—T. L. Smith Co., Milwaukee, Wis.; 16 pp. and cover, 5 in. by 8 in., in two colors, illustrated. This booklet describes the characteristics of the Smith line of paving mixers, and illustrates clearly their outstanding features. A table of specifications is included.

Heil Bodies and Hoists, Catalog No. 120—The Heil Co., Milwaukee, Wis.; 16 pp., 8½ in. by 11 in., printed in two colors, illustrated; describing the various Heil equipment and accessories for dumping bodies.

The Besser—Besser Sales Co., Monadnock Building, Chicago; 16 pp. and cover, 8½ in. by 11 in., llustrated, printed in twoi colors; describing and illustrating the Besser double automatic building tile machine and the market and use of the unit. Written for the man who wishes to investigate the business.

Heil Gravity Dump Body for Ford Trucks, Bulletin No. 120-E—The Heil Co., Milwaukee, Wis., 4 pp., describing and illustrating a new dump body, in three capacities, 1, 1¼, and 1½ yds., for use on a Ford chassis. The special advantages claimed for this dump body are that it handles either wet or dry mix concrete, all bulk materials such as coal, slag, ore, sand, etc.; that it dumps its load clear of the wheels, and requires no power to operate it, as gravity does the work, the driver tripping the body without leaving his seat.



NEW TREADWELL, SMALL PORTABLE HOIST—CAPACITY 1,500 LBS. AT 100 FT. PER MINUTE

An Unusual Small Hoist

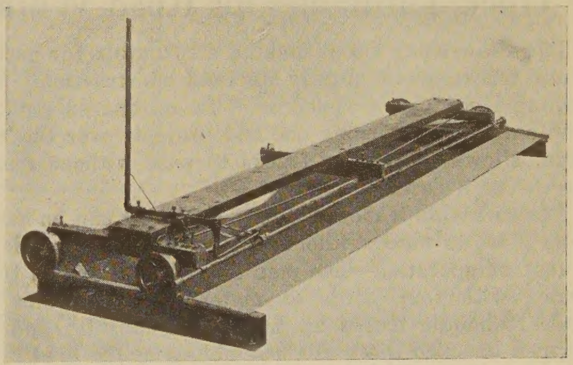
There has recently been placed on the market by the Treadwell Engineering Co., at Easton, Pa., a self-contained, small portable hoist, radically different from equipment heretofore available. It was produced with the idea of providing a machine for light hoisting and hauling, which should be mechanically dependable and both safe from injury to its mechanism and safe against injuring a heedless workman. It is intended for unnumbered odd jobs which have required the effort of one, two or a half dozen men—hauling timbers and planking, skidding concrete mixers and other equipment, hoisting materials, placing concrete forms, and the like.

As the illustration shows, this hoist is wholly enclosed in a heavy sheet steel plate casing, mounted on a half-inch steel sole plate. The unit casting forms the support for the drum and gear shaft bearings, which latter are electric steel castings, fitted with renewable bronze bushings and lubricated from a waste packed oil reservoir. The controller box and resistance panel are, of necessity, mounted on the exterior of the casing.

This little hoist is provided with a clutch manipulated by a lever at the operator's end of the hoist, which lever is automatically locked either *in* or *out.* Control of the load is effected by a powerful hand brake. The 8 x 12 in. drum has a capacity of 1500 ft. of ⅜ in. wire rope and the rated hoisting capacity of 1500 lbs. at a speed of 100 ft. per minute. The standard motor employed is of 5 h.p., operating at 1200 r.p.m. The entire hoist measures 2 ft. x 2 ft. x 4 ft. 6 in. over all.

The Lakewood Float-Bridge

The Lakewood Engineering Co., Cleveland, has brought out a Float-Bridge for concrete road construction. It is a hand operated belt float and substantial bridge combined. One man operates the lever which moves the belt back and forth across the pavement, at the same time automatically advancing the machine a little with each stroke. The traction mechanism can be instantly thrown out of gear so that the Float-Bridge can be pushed forward or backward. The belt can be raised off the pavement and is automatically held up until released.

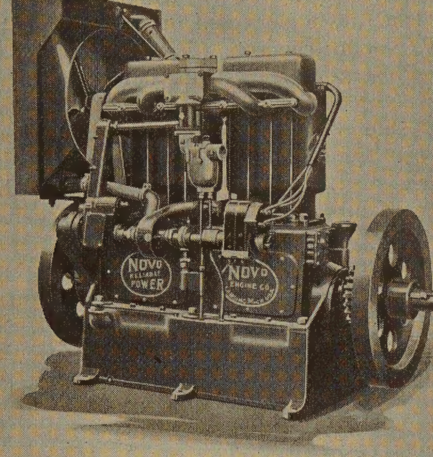


LAKEWOOD FLOAT BRIDGE

On many concrete paving jobs it has been found that a final belting some little time after the pavement has been struck off, tamped and surfaced does much to prevent hair cracks and also gives a better surface. Time does not allow the finishing machine to go back and do this final belting, and it was primarily for this work that the Float-Bridge was developed.

Contractor's Multiple Cylinder Engine

Just a few months ago CONCRETE called attention to the possibility of the multiple cylinder engine in the industrial field. Announcement is now made by the Novo Engine Co., Lansing, Mich., that, having recognized a new need of and demand for gasoline engines of higher horse power in the contractor's field, it has put on the market a new series of gasoline engines of the four-cylinder, four-cycle vertical type. This new series will be known as Novo Type F and consist of three models—3¼-in. bore and 5-in. stroke; 4-in. bore and 5½-in. stroke and 4¾-in. bore and 6-in. stroke. The Type F engines are somewhat heavier than the tractor or truck type of four-cylinder engine. They are slower in speed and have heavier crankshafts and larger bearings. In short, they are in every respect made exclusively for use with industrial equipment. They cover the field from 10 to 40 h.p.

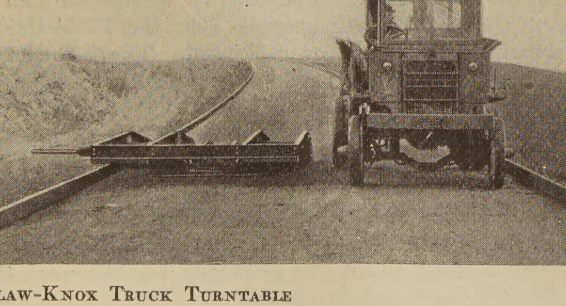


NOVO 4—CYLINDER ENGINE

Truck Turntables for Road Work

The Blaw-Knox Co. is making a turntable for getting motor trucks about quickly on road construction. The turntable occupies a space of 8 ft. on one side of the road only and in turning one end projects over the road form, allowing outgoing trucks to pass without removing the road forms.

The turntable is mounted on a skid so it can be moved from place to place without tearing up the subgrade. It is easy of operation—one man can turn a five ton truck loaded with four yards of material. Turntables are made to handle trucks up to five-ton capacity and are shipped knocked down for assembling in the field.



BLAW-KNOX TRUCK TURNTABLE

Organizations

American Concrete Institute; Secretary, Harvey Whipple, 1807 East Grand Boulevard, Detroit.

American Concrete Pipe Association, M. W. Loving, Secretary, 111 West Washington St., Chicago.

Associated Metal Lath Manufacturers, Edison Bldg., Chicago; Wharton Clay, Commissioner.

Iowa Cement Stave Silo Association; H. E. Kilmer, Secretary, Oskaloosa, Ia.

Mid-West Concrete Products Assn., Frank Whipperman, Secretary-Treasurer, 3045 Fowler Bldg., Omaha, Neb.

National Crushed Stone Assn.; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Assn.; Lawrence Veiller, Secretary and Director, 105 East 22nd St., N. Y. C.

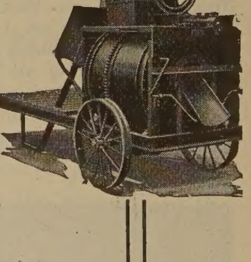
The National Lime Association; Mather Bldg., Washington, D. C.

National Sand and Gravel Producers' Association; E. Guy Sutton, Secretary, Williamsport, Ind.

The National Concrete Stave Silo Asociation; W. G. Kaiser, Secretary, 111 West Washington St., Chicago.

A woodworking machine that is a complete, portable planing mill, operating on any lamp circuit has been put on the market by the Hutchinson Manufacturing Co., Norristown, Pa. It performs numerous operations and can be installed almost anywhere. It should be useful as a labor saver on concrete form work.

ARCHER
Batch Mixers



Built in three sizes. Three feet, five feet and seven feet wet mix capacity. Engine mounted on top, out of the way. Low charging, fast discharge. As easily moved as a wheelbarrow. Write for catalog.

ARCHER IRON WORKS
2426 West 34th Place
Chicago, Ill.

SAMSON SPOT SASH CORD

SAMSON CORDAGE WORKS, BOSTON, MASS.